1. Jake wants to buy a car and hopes to save at least $5000 for a down payment. The table below summarizes the amount of money he plans to save each week.

| Week | 1   | 2   | 3    | 4    | 5    | ...
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Money Saved, in Dollars</td>
<td>2</td>
<td>5</td>
<td>12.5</td>
<td>31.25</td>
<td>...</td>
<td></td>
</tr>
</tbody>
</table>

Based on this plan, which expression should he use to determine how much he has saved in \( n \) weeks?

1) \( \frac{2 - 2(2.5^n)}{1 - 2.5} \)

2) \( \frac{2 - 2(2.5^{n-1})}{1 - 2.5} \)

3) \( \frac{1 - 2.5^n}{1 - 2.5} \)

4) \( \frac{1 - 2.5^{n-1}}{1 - 2.5} \)

2. Consider the function \( h(x) = 2 \sin(3x) + 1 \) and the function \( q \) represented in the table below.

<table>
<thead>
<tr>
<th>( x )</th>
<th>( q(x) )</th>
</tr>
</thead>
<tbody>
<tr>
<td>-2</td>
<td>-8</td>
</tr>
<tr>
<td>-1</td>
<td>0</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>-2</td>
</tr>
<tr>
<td>2</td>
<td>0</td>
</tr>
</tbody>
</table>

Determine which function has the smaller minimum value for the domain \([-2, 2]\). Justify your answer.

3. Perry invested in property that cost him $1500. Five years later it was worth $3000, and 10 years from his original purchase, it was worth $6000. Assuming the growth rate remains the same, which type of function could he create to find the value of his investment 30 years from his original purchase?

1) exponential function

2) linear function

3) quadratic function

4) trigonometric function

4. If $5000 is put into a savings account that pays 3.5% interest compounded monthly, how much money, to the nearest ten cents, would be in that account after 6 years, assuming no money was added or withdrawn?

1) $5177.80

2) $5941.30

3) $6146.30

4) $6166.50
5. For the system shown below, what is the value of $z$?

\[
\begin{align*}
y &= -2x + 14 \\
3x - 4z &= 2 \\
3x - y &= 16
\end{align*}
\]

1) 5  
2) 2  
3) 6  
4) 4

6. Solve algebraically for all values of $x$:

\[
\sqrt{6 - 2x} + x = 2(x + 15) - 9
\]

7. On average, college seniors graduating in 2012 could compute their growing student loan debt using the function $D(t) = 29,400(1.068)^t$, where $t$ is time in years. Which expression is equivalent to $29,400(1.068)^t$ and could be used by students to identify an approximate daily interest rate on their loans?

1) $29,400 \left( \frac{1}{365} \right)^t$  
2) $29,400 \left( \frac{1.068}{365} \right)^t$  
3) $29,400 \left( 1 + \frac{0.068}{365} \right)^t$  
4) $29,400 \left( \frac{1}{365} \right)^{365t}$

8. When the function $p(x)$ is divided by $x - 1$ the quotient is $x^2 + 7 + \frac{5}{x - 1}$. State $p(x)$ in standard form.

9. The expression $6 - (3x - 2i)^2$ is equivalent to

1) $-9x^2 + 12xi + 10$  
2) $9x^2 - 12xi + 2$  
3) $-9x^2 + 10$  
4) $-9x^2 + 12xi - 4i + 6$

10. Susan won $2,000 and invested it into an account with an annual interest rate of 3.2%. If her investment were compounded monthly, which expression best represents the value of her investment after $t$ years?

1) $2000(1.003)^{12t}$  
2) $2000(1.032)^{t/12}$  
3) $2064^{t/12}$  
4) $\frac{2000(1.032)^t}{12}$

11. The height, $h(t)$ in cm, of a piston, is given by the equation $h(t) = 12 \cos \left( \frac{\pi}{3} \cdot \frac{t}{365} \right) + 8$, where $t$ represents the number of seconds since the measurements began. Determine the average rate of change, in cm/sec, of the piston's height on the interval $1 \leq t \leq 2$. At what value(s) of $t$, to the nearest tenth of a second, does $h(t) = 0$ in the interval $1 \leq t \leq 5$? Justify your answer.
12. Explain what a rational exponent, such as $\frac{5}{2}$, means.

Use this explanation to evaluate $9^{\frac{5}{2}}$.

13. A scatterplot showing the weight, $w$, in grams, of each crystal after growing $t$ hours is shown below.

The relationship between weight, $w$, and time, $t$, is best modeled by

1) $w = 4^t + 5$

2) $w = (1.4)^t + 2$

3) $w = 5(2.1)^t$

4) $w = 8(.75)^t$

14. Write a recursive formula, $a_n$, to describe the sequence graphed below.

15. Consider the function $p(x) = 3x^3 + x^2 - 5x$ and the graph of $y = m(x)$ below.

Which statement is true?

1) $p(x)$ has three real roots and $m(x)$ has two real roots.

2) $p(x)$ has one real root and $m(x)$ has two real roots.

3) $p(x)$ has two real roots and $m(x)$ has three real roots.

4) $p(x)$ has three real roots and $m(x)$ has four real roots.

16. There are 400 students in the senior class at Oak Creek High School. All of these students took the SAT. The distribution of their SAT scores is approximately normal. The number of students who scored within 2 standard deviations of the mean is approximately

1) 75

2) 95

3) 300

4) 380
17 Sodium iodide-131, used to treat certain medical conditions, has a half-life of 1.8 hours. The data table below shows the amount of sodium iodide-131, rounded to the nearest thousandth, as the dose fades over time.

<table>
<thead>
<tr>
<th>Number of Half Lives</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amount of Sodium Iodide-131</td>
<td>139.000</td>
<td>69.500</td>
<td>34.750</td>
<td>17.375</td>
<td>8.688</td>
</tr>
</tbody>
</table>

What approximate amount of sodium iodide-131 will remain in the body after 18 hours?
1) 0.001  3) 0.271
2) 0.136  4) 0.543

18 Written in simplest form, the fraction \( \frac{x^3 - 9x}{9 - x^2} \), where \( x \neq \pm 3 \), is equivalent to
1) \(-x\)
2) \(x\)
3) \(\frac{-x(x + 3)}{(3 + x)}\)
4) \(\frac{x(x - 3)}{(3 - x)}\)

20 The half-life of a radioactive substance is 15 years. Write an equation that can be used to determine the amount, \( s(t) \), of 200 grams of this substance that remains after \( t \) years. Determine algebraically, to the nearest year, how long it will take for \( \frac{1}{10} \) of this substance to remain.

21 Brian deposited 1 cent into an empty non-interest bearing bank account on the first day of the month. He then additionally deposited 3 cents on the second day, 9 cents on the third day, and 27 cents on the fourth day. What would be the total amount of money in the account at the end of the 20th day if the pattern continued?
1) $11,622,614.67
2) $17,433,922.00
3) $116,226,146.80
4) $1,743,392,200.00

22 Explain why \( 81^{\frac{3}{4}} \) equals 27.
23 Where \( i \) is the imaginary unit, the expression \((x + 3i)^2 - (2x - 3i)^2\) is equivalent to
1) \(-3x^2\)
2) \(-3x^2 - 18\)
3) \(-3x^2 + 18xi\)
4) \(-3x^2 - 6xi - 18\)

24 What is the quotient when \(10x^3 - 3x^2 - 7x + 3\) is divided by \(2x - 1\)?
1) \(5x^2 + x + 3\)
2) \(5x^2 - x + 3\)
3) \(5x^2 - x - 3\)
4) \(5x^2 + x - 3\)

25 The value(s) of \(x\) that satisfy \(\sqrt{x^2 - 4x - 5} = 2x - 10\) are
1) \{5\}
2) \{7\}
3) \{5, 7\}
4) \{3, 5, 7\}

26 Julia deposits $2000 into a savings account that earns 4% interest per year. The exponential function that models this savings account is \(y = 2000(1.04)^t\), where \(t\) is the time in years. Which equation correctly represents the amount of money in her savings account in terms of the monthly growth rate?
1) \(y = 166.67(1.04)^{0.12t}\)
2) \(y = 2000(1.01)^t\)
3) \(y = 2000(1.0032737)^t\)
4) \(y = 166.67(1.0032737)^t\)

27 Which expression is equivalent to \(\frac{2x^4 + 8x^3 - 25x^2 - 6x + 14}{x + 6}\)?
1) \(2x^3 + 4x^2 + x - 12 + \frac{86}{x + 6}\)
2) \(2x^3 - 4x^2 - x + 14\)
3) \(2x^3 - 4x^2 - x + \frac{14}{x + 6}\)
4) \(2x^3 - 4x^2 - x\)

28 The expression \((x + a)^2 + 5(x + a) + 4\) is equivalent to
1) \((a + 1)(a + 4)\)
2) \((x + 1)(x + 4)\)
3) \((x + a + 1)(x + a + 4)\)
4) \(x^2 + a^2 + 5x + 5a + 4\)

29 The first term of a geometric sequence is 8 and the fourth term is 216. What is the sum of the first 12 terms of the corresponding series?
1) 236,192
2) 708,584
3) 2,125,760
4) 6,377,288

30 The temperature, in degrees Fahrenheit, in Times Square during a day in August can be predicted by the function \(T(x) = 8\sin(0.3x - 3) + 74\), where \(x\) is the number of hours after midnight. According to this model, the predicted temperature, to the nearest degree Fahrenheit, at 7 P.M. is
1) 68
2) 74
3) 77
4) 81
31 A radio station claims to its advertisers that the mean number of minutes commuters listen to the station is 30. The station conducted a survey of 500 of their listeners who commute. The sample statistics are shown below.

<table>
<thead>
<tr>
<th>$\bar{x}$</th>
<th>29.11</th>
</tr>
</thead>
<tbody>
<tr>
<td>$s_x$</td>
<td>20.718</td>
</tr>
</tbody>
</table>

A simulation was run 1000 times based upon the results of the survey. The results of the simulation appear below.

Based on the simulation results, is the claim that commuters listen to the station on average 30 minutes plausible? Explain your response including an interval containing the middle 95% of the data, rounded to the nearest hundredth.

32 The solutions to $x + 3 - \frac{4}{x - 1} = 5$ are

1) $\frac{3}{2} \pm \frac{\sqrt{17}}{2}$
2) $\frac{3}{2} \pm \frac{\sqrt{17}}{2}i$
3) $\frac{3}{2} \pm \frac{\sqrt{33}}{2}$
4) $\frac{3}{2} \pm \frac{\sqrt{33}}{2}i$

33 If $p(x) = 2 \ln(x) - 1$ and $m(x) = \ln(x + 6)$, then what is the solution for $p(x) = m(x)$?

1) 1.65
2) 3.14
3) 5.62
4) no solution

34 Suppose events $A$ and $B$ are independent and $P(A \text{ and } B)$ is 0.2. Which statement could be true?

1) $P(A) = 0.4, P(B) = 0.3, P(A \text{ or } B) = 0.5$
2) $P(A) = 0.8, P(B) = 0.25$
3) $P(A | B) = 0.2, P(B) = 0.2$
4) $P(A) = 0.15, P(B) = 0.05$
35 For a given time, \( x \), in seconds, an electric current, \( y \), can be represented by \( y = 2.5 \left( 1 - 2.7^{-10x} \right) \).
Which equation is not equivalent?
1) \( y = 2.5 - 2.7 \left( 2.7^{-10x} \right) \)
2) \( y = 2.5 - 2.5 \left( 2.7^2 \right)^{-0.5x} \)
3) \( y = 2.5 - 2.5 \left( \frac{1}{2.7^{10x}} \right) \)
4) \( y = 2.5 - 2.5 \left( 2.7^{-2} \right) \left( 2.7^{0.5x} \right) \)

36 Which equation represents the equation of the parabola with focus \((-3, 3)\) and directrix \( y = 7 \)?
1) \( y = \frac{1}{8} (x + 3)^2 - 5 \)
2) \( y = \frac{1}{8} (x - 3)^2 + 5 \)
3) \( y = -\frac{1}{8} (x + 3)^2 + 5 \)
4) \( y = -\frac{1}{8} (x - 3)^2 + 5 \)

37 The graph of \( y = \log_2 x \) is translated to the right 1 unit and down 1 unit. The coordinates of the \( x \)-intercept of the translated graph are
1) \((0, 0)\)
2) \((1, 0)\)
3) \((2, 0)\)
4) \((3, 0)\)

38 A number, minus twenty times its reciprocal, equals eight. The number is
1) 10 or \(-2\)
2) 10 or 2
3) \(-10\) or \(-2\)
4) \(-10\) or 2

39 A formula for work problems involving two people is shown below.
\[
\frac{1}{t_1} + \frac{1}{t_2} = \frac{1}{t_b}
\]

\( t_1 \) = the time taken by the first person to complete the job
\( t_2 \) = the time taken by the second person to complete the job
\( t_b \) = the time it takes for them working together to complete the job
Fred and Barney are carpenters who build the same model desk. It takes Fred eight hours to build the desk while it only takes Barney six hours. Write an equation that can be used to find the time it would take both carpenters working together to build a desk. Determine, to the nearest tenth of an hour, how long it would take Fred and Barney working together to build a desk.

40 Which equation represents a parabola with a focus of \((-2, 5)\) and a directrix of \( y = 9 \)?
1) \((y - 7)^2 = 8(x + 2)\)
2) \((y - 7)^2 = -8(x + 2)\)
3) \((x + 2)^2 = 8(y - 7)\)
4) \((x + 2)^2 = -8(y - 7)\)
41 The solution set for the equation \( b = \sqrt{2b^2 - 64} \) is
1) \( \{ -8 \} \)
2) \( \{ 8 \} \)
3) \( \{ \pm 8 \} \)
4) \( \{ \} \)

42 Consider the system below.

\[
\begin{align*}
    x + y + z &= 9 \\
    x - y - z &= -1 \\
    x - y + z &= 21
\end{align*}
\]

Which value is not in the solution, \((x,y,z)\), of the system?
1) \(-8\)
2) \(-6\)
3) \(11\)
4) \(4\)

43 What is the solution set of the following system of equations?

\[
\begin{align*}
y &= 3x + 6 \\
y &= (x + 4)^2 - 10
\end{align*}
\]

1) \(\{ (-5,-9) \} \)
2) \(\{ (5,21) \} \)
3) \(\{ (0,6), (-5,-9) \} \)
4) \(\{ (0,6), (5,21) \} \)

44 If \( (a^3 + 27) = (a + 3) \left( a^2 + ma + 9 \right) \), then \( m \) equals
1) \(-9\)
2) \(-3\)
3) \(3\)
4) \(6\)

45 What is the solution set for \( x \) in the equation below?

\[ \sqrt{x + 1} - 1 = x \]

1) \(\{ 1 \} \)
2) \(\{ 0 \} \)
3) \(\{ -1, 0 \} \)
4) \(\{ 0, 1 \} \)

46 Expressed in simplest form,

\[
(7 - 3i) + (x - 2i)^2 - (4i + 2x^2) \]

1) \((3 - x^2) - (4x + 7)i\)
2) \((3 + 3x^2) - (4x + 7)i\)
3) \((3 - x^2) - 7i\)
4) \((3 + 3x^2) - 7i\)

47 Solve the following system of equations algebraically for all values of \(x, y,\) and \(z\):

\[
\begin{align*}
2x + 3y - 4z &= -1 \\
x - 2y + 5z &= 3 \\
-4x + y + z &= 16
\end{align*}
\]

48 If \( a e^{bt} = c \), where \( a, b, \) and \( c \) are positive, then \( t \) equals

1) \( \ln \left( \frac{c}{ab} \right) \)
2) \( \ln \left( \frac{cb}{a} \right) \)
3) \( \ln \left( \frac{c}{a} \right) \)
4) \( \ln \left( \frac{c}{a} \right) \)

\( \ln b \)
49 For \( x > 0 \), which expression is equivalent to \( \frac{\sqrt[3]{x^2} \cdot \sqrt[6]{x^5}}{\sqrt[6]{x}} \)?

1) \( x \)

2) \( x^{\frac{3}{2}} \)

3) \( x^3 \)

4) \( x^{10} \)

50 Which representation of a quadratic has imaginary roots?

\[
\begin{array}{|c|c|}
\hline
x & y \\
\hline
-2.5 & 2 \\
-2.0 & 0 \\
-1.5 & -1 \\
-1.0 & -1 \\
-0.5 & 0 \\
0.0 & 2 \\
\hline
\end{array}
\]

1) \( 2(x + 3)^2 = 64 \)

2) \( 2(x + 3)^2 = 64 \)

3) \( 2x^2 + 32 = 0 \)

51 Given: \( f(x) = 2x^2 + x - 3 \) and \( g(x) = x - 1 \)

Express \( f(x) \cdot g(x) - [f(x) + g(x)] \) as a polynomial in standard form.

52 What is the solution when the equation \( wx^2 + w = 0 \) is solved for \( x \), where \( w \) is a positive integer?

1) \(-1\)

2) \(0\)

3) \(6\)

4) \(\pm i\)

53 When factoring to reveal the roots of the equation \( x^3 + 2x^2 - 9x - 18 = 0 \), which equations can be used?

I. \( x^2(x + 2) - 9(x + 2) = 0 \)

II. \( x(x^2 - 9) + 2(x^2 - 9) = 0 \)

III. \( (x - 2)(x^2 - 9) = 0 \)

1) I and II, only

2) I and III, only

3) II and III, only

4) I, II, and III

54 Given \( \cos \theta = \frac{7}{25} \), where \( \theta \) is an angle in standard position terminating in quadrant IV, and \( \sin^2 \theta + \cos^2 \theta = 1 \), what is the value of \( \tan \theta \)?

1) \( \frac{-24}{25} \)

2) \( \frac{-24}{7} \)

3) \( \frac{24}{25} \)

4) \( \frac{24}{7} \)
55. A group of students was trying to determine the proportion of candies in a bag that are blue. The company claims that 24% of candies in bags are blue. A simulation was run 100 times with a sample size of 50, based on the premise that 24% of the candies are blue. The approximately normal results of the simulation are shown in the dot plot below.

The simulation results in a mean of 0.254 and a standard deviation of 0.060. Based on this simulation, what is a plausible interval containing the middle 95% of the data?

1) $(0.194, 0.314)$
2) $(0.134, 0.374)$
3) $(-0.448, 0.568)$
4) $(0.254, 0.374)$

56. A runner is using a nine-week training app to prepare for a "fun run." The table below represents the amount of the program completed, $A$, and the distance covered in a session, $D$, in miles.

<table>
<thead>
<tr>
<th>$A$</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>8</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>$D$</td>
<td>2</td>
<td>2.25</td>
<td>3</td>
<td>3.25</td>
<td></td>
</tr>
</tbody>
</table>

Based on these data, write an exponential regression equation, rounded to the nearest thousandth, to model the distance the runner is able to complete in a session as she continues through the nine-week program.

57. The roots of the equation $3x^2 + 2x = -7$ are

1) $-2, -\frac{1}{3}$
2) $-\frac{7}{3}, 1$
3) $\frac{1}{3} \pm \frac{2i\sqrt{5}}{3}$
4) $\frac{1}{3} \pm \frac{\sqrt{11}}{3}$

58. Which investigation technique is most often used to determine if a single variable has an impact on a given population?

1) observational study
2) random survey
3) controlled experiment
4) formal interview
59. To determine if the type of music played while taking a quiz has a relationship to results, 16 students were randomly assigned to either a room softly playing classical music or a room softly playing rap music. The results on the quiz were as follows:

Classical: 74, 83, 77, 77, 84, 82, 90, 89
Rap: 77, 80, 78, 74, 69, 72, 78, 69

John correctly rounded the difference of the means of his experimental groups as 7. How did John obtain this value and what does it represent in the given context? Justify your answer. To determine if there is any significance in this value, John rerandomized the 16 scores into two groups of 8, calculated the difference of the means, and simulated this process 250 times as shown below.

Does the simulation support the theory that there may be a significant difference in quiz scores? Explain.

60. The solution of \(87e^{0.3x} = 5918\), to the nearest thousandth, is

1) 0.583  
2) 1.945  
3) 4.220  
4) 14.066

61. If \(f(x)\) is an even function, which function must also be even?

1) \(f(x - 2)\)  
2) \(f(x) + 3\)  
3) \(f(x + 1)\)  
4) \(f(x + 1) + 3\)
62 Mary bought a pack of candy. The manufacturer claims that 30% of the candies manufactured are red. In her pack, 14 of the 60 candies are red. She ran a simulation of 300 samples, assuming the manufacturer is correct. The results are shown below.

Based on the simulation, determine the middle 95% of plausible values that the proportion of red candies in a pack is within. Based on the simulation, is it unusual that Mary’s pack had 14 red candies out of a total of 60? Explain.

63 Juan and Filipe practice at the driving range before playing golf. The number of wins and corresponding practice times for each player are shown in the table below.

<table>
<thead>
<tr>
<th>Practice Time</th>
<th>Juan Wins</th>
<th>Felipe Wins</th>
</tr>
</thead>
<tbody>
<tr>
<td>Short Practice Time</td>
<td>8</td>
<td>10</td>
</tr>
<tr>
<td>Long Practice Time</td>
<td>15</td>
<td>12</td>
</tr>
</tbody>
</table>

Given that the practice time was long, determine the exact probability that Filipe wins the next match. Determine whether or not the two events “Filipe wins” and “long practice time” are independent. Justify your answer.

64 At her job, Pat earns $25,000 the first year and receives a raise of $1000 each year. The explicit formula for the nth term of this sequence is 

\[ a_n = 25,000 + (n - 1)1000. \]

Which rule best represents the equivalent recursive formula?

1) \[ a_n = 24,000 + 1000n \]
2) \[ a_n = 25,000 + 1000n \]
3) \[ a_1 = 25,000, a_n = a_{n-1} + 1000 \]
4) \[ a_1 = 25,000, a_n = a_{n+1} + 1000 \]

65 The expression \( 2 - \frac{x - 1}{x + 2} \) is equivalent to

1) \( 1 - \frac{3}{x + 2} \)
2) \( 1 + \frac{3}{x + 2} \)
3) \( 1 - \frac{1}{x + 2} \)
4) \( 1 + \frac{1}{x + 2} \)
66 Camryn puts $400 into a savings account that earns 6% annually. The amount in her account can be modeled by \( C(t) = 400(1.06)^t \) where \( t \) is the time in years. Which expression best approximates the amount of money in her account using a weekly growth rate?

1) \( 400(1.001153846)^t \)
2) \( 400(1.001121184)^t \)
3) \( 400(1.001153846)^{52t} \)
4) \( 400(1.001121184)^{52t} \)

67 For \( x \geq 0 \), which equation is false?

1) \( \left( x^\frac{3}{2} \right)^2 = 4\sqrt{x^3} \)
2) \( \left( x^\frac{1}{2} \right)^4 = 4\sqrt{x^3} \)
3) \( \left( x^{-\frac{3}{2}} \right)^\frac{1}{3} = \sqrt[3]{x^{-3}} \)
4) \( (x^{-\frac{3}{2}})^2 = 3\sqrt{x^4} \)

68 A fast-food restaurant analyzes data to better serve its customers. After its analysis, it discovers that the events \( D \), that a customer uses the drive-thru, and \( F \), that a customer orders French fries, are independent. The following data are given in a report:

\[
P(F) = 0.8 \]
\[
P(F \cap D) = 0.456
\]

Given this information, \( P(F|D) \) is

1) 0.344
2) 0.3648
3) 0.57
4) 0.8

69 Point \( M \left( \frac{4}{7}, \frac{t}{7} \right) \) is located in the second quadrant on the unit circle. Determine the exact value of \( t \).

70 Given the following polynomials

\[
x = (a + b + c)^2
\]
\[
y = a^2 + b^2 + c^2
\]
\[
z = ab + bc + ac
\]

Which identity is true?

1) \( x = y - z \)
2) \( x = y + z \)
3) \( x = y - 2z \)
4) \( x = y + 2z \)

71 Evan graphed a cubic function,

\[ f(x) = ax^3 + bx^2 + cx + d \]

, and determined the roots of \( f(x) \) to be \( \pm 1 \) and 2. What is the value of \( b \), if \( a = 1 \)?

1) 1
2) 2
3) -1
4) -2

72 When the expression \((x + 2)^2 + 4(x + 2) + 3\) is rewritten as the product of two binomials, the result is

1) \((x + 3)(x + 1)\)
2) \((x + 5)(x + 3)\)
3) \((x + 2)(x + 2)\)
4) \((x + 6)(x + 1)\)
73. The graphs of the equations \( y = x^2 + 4x - 1 \) and 
\( y + 3 = x \) are drawn on the same set of axes. One 
solution of this system is 
1) \((-5, -2)\) 
2) \((-1, -4)\) 
3) \((1, 4)\) 
4) \((-2, -1)\)

74. The average depreciation rate of a new boat is 
approximately 8% per year. If a new boat is 
purchased at a price of $75,000, which model is a 
recursive formula representing the value of the boat 
\( n \) years after it was purchased? 
1) \(a_n = 75,000(0.08)^n\) 
2) \(a_0 = 75,000\) 
3) \(a_n = 75,000(1.08)^n\) 
4) \(a_0 = 75,000\) 
\(a_n = 0.92(a_{n-1})\)

75. An estimate of the number of milligrams of a 
medication in the bloodstream \( t \) hours after 400 mg 
has been taken can be modeled by the function 
below. 
\[ I(t) = 0.5t^3 + 3.45t^2 - 96.65t^2 + 347.7t, \] 
where \( 0 \leq t \leq 6 \)
Over what time interval does the amount of 
medication in the bloodstream strictly increase? 
1) 0 to 2 hours 
2) 0 to 3 hours 
3) 2 to 6 hours 
4) 3 to 6 hours

76. What is the solution set of the equation 
\[ \frac{2}{3x + 1} = \frac{1}{x} - \frac{6x}{3x + 1}? \] 
1) \(\left\{ \frac{1}{3}, \frac{1}{2} \right\}\) 
2) \(\left\{ \frac{1}{3} \right\}\) 
3) \(\left\{ \frac{1}{2} \right\}\) 
4) \(\left\{ \frac{1}{3}, -2 \right\}\)

77. Which expression is equivalent to 
\(x^6 y^4 (x^4 - 16) - 9(x^4 - 16)?\) 
1) \(x^{10} y^4 - 16x^6 y^4 - 9x^4 - 144\) 
2) \((x^6 y^4 - 9)(x + 2)^3(x - 2)\) 
3) \((x^3 y^2 + 3)(x^3 y^2 - 3)(x + 2)^3(x - 2)^2\) 
4) \((x^3 y^2 + 3)(x^3 y^2 - 3)(x^2 + 4)(x^2 - 4)\)

78. Elizabeth tried to find the product of \((2 + 4i)\) and 
\((3 - i)\), and her work is shown below. 
\[(2 + 4i)(3 - i)\]  
\[= 6 - 2i + 12i - 4i^2\]  
\[= 6 + 10i - 4(1)\]  
\[= 6 + 10i - 4\]  
\[= 2 + 10i\]
Identify the error in the process shown and 
determine the correct product of \((2 + 4i)\) and \((3 - i)\).
### 79 Selected values for the functions $f$ and $g$ are shown in the tables below.

<table>
<thead>
<tr>
<th>$x$</th>
<th>$f(x)$</th>
<th>$x$</th>
<th>$g(x)$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$-3.12$</td>
<td>$-4.88$</td>
<td>$-2.01$</td>
<td>$-1.01$</td>
</tr>
<tr>
<td>$0$</td>
<td>$-6$</td>
<td>$0$</td>
<td>$0.58$</td>
</tr>
<tr>
<td>$1.23$</td>
<td>$-4.77$</td>
<td>$8.52$</td>
<td>$2.53$</td>
</tr>
<tr>
<td>$8.52$</td>
<td>$2.53$</td>
<td>$13.11$</td>
<td>$3.01$</td>
</tr>
<tr>
<td>$9.01$</td>
<td>$3.01$</td>
<td>$16.52$</td>
<td>$3.29$</td>
</tr>
</tbody>
</table>

A solution to the equation $f(x) = g(x)$ is

1) 0
2) 2.53
3) 3.01
4) 8.52

### 80 Consider the following patterns:

I. 16, $-12, 9, -6.75, \ldots$
II. 1, 4, 9, 16, $\ldots$
III. 6, 18, 30, 42, $\ldots$
IV. $\frac{1}{2}, \frac{2}{3}, \frac{3}{4}, \frac{4}{5}, \ldots$

Which pattern is geometric?

1) I
2) II
3) III
4) IV

### 81 Written in simplest form, $\frac{c^2 - d^2}{d^2 + cd - 2c^2}$ where $c \neq d$, is equivalent to

1) $\frac{c + d}{d + 2c}$
2) $\frac{c - d}{d + 2c}$
3) $\frac{-c - d}{d + 2c}$
4) $\frac{-c + d}{d + 2c}$

### 82 Algebraically solve for $x$: $\frac{7}{2x} - \frac{2}{x + 1} = \frac{1}{4}$

### 83 Determine, to the nearest tenth of a year, how long it would take an investment to double at a $\frac{3}{4}\%$ interest rate, compounded continuously.

### 84 An angle, $\theta$, is in standard position and its terminal side passes through the point $(2, -1)$. Find the exact value of $\sin \theta$.

### 85 What is the inverse of the function $y = 4x + 5$?

1) $x = \frac{1}{4}y - \frac{5}{4}$
2) $y = \frac{1}{4}x - \frac{5}{4}$
3) $y = 4x - 5$
4) $y = \frac{1}{4x + 5}$
86 Researchers in a local area found that the population of rabbits with an initial population of 20 grew continuously at the rate of 5% per month. The fox population had an initial value of 30 and grew continuously at the rate of 3% per month. Find, to the nearest tenth of a month, how long it takes for these populations to be equal.

87 The graph of \( y = f(x) \) is shown below. The function has a leading coefficient of 1.

Write an equation for \( f(x) \). The function \( g \) is formed by translating function \( f \) left 2 units. Write an equation for \( g(x) \).

88 What is the equation of the directrix for the parabola \(-8(y - 3) = (x + 4)^2\)?
1) \( y = 5 \)
2) \( y = 1 \)
3) \( y = -2 \)
4) \( y = -6 \)

89 Griffin is riding his bike down the street in Churchville, N.Y. at a constant speed, when a nail gets caught in one of his tires. The height of the nail above the ground, in inches, can be represented by the trigonometric function

\[ f(t) = -13 \cos(0.8\pi t) + 13, \]

where \( t \) represents the time (in seconds) since the nail first became caught in the tire. Determine the period of \( f(t) \). Interpret what the period represents in this context. On the grid below, graph at least one cycle of \( f(t) \) that includes the \( y \)-intercept of the function.

Does the height of the nail ever reach 30 inches above the ground? Justify your answer.

90 The mean intelligence quotient (IQ) score is 100, with a standard deviation of 15, and the scores are normally distributed. Given this information, the approximate percentage of the population with an IQ greater than 130 is closest to
1) 2%
2) 31%
3) 48%
4) 95%
91 The profit function, \( p(x) \), for a company is the cost function, \( c(x) \), subtracted from the revenue function, \( r(x) \). The profit function for the Acme Corporation is \( p(x) = -0.5x^2 + 250x - 300 \) and the revenue function is \( r(x) = -0.3x^2 + 150x \). The cost function for the Acme Corporation is

1) \( c(x) = 0.2x^2 - 100x + 300 \)
2) \( c(x) = 0.2x^2 + 100x + 300 \)
3) \( c(x) = -0.2x^2 + 100x - 300 \)
4) \( c(x) = -0.8x^2 + 400x - 300 \)

92 Consider \( f(x) = 4x^2 + 6x - 3 \), and \( p(x) \) defined by the graph below.

![Graph of p(x)](image)

The difference between the values of the maximum of \( p \) and minimum of \( f \) is

1) 0.25
2) 1.25
3) 3.25
4) 10.25

93 What is the solution set of the equation

\[
\frac{10}{x^2 - 2x} + \frac{4}{x} = \frac{5}{x - 2}.
\]

1) \( \{0, 2\} \)
2) \( \{0\} \)
3) \( \{2\} \)
4) \( \{\} \)

94 The Fahrenheit temperature, \( F(t) \), of a heated object at time \( t \), in minutes, can be modeled by the function below. \( F_s \) is the surrounding temperature, \( F_0 \) is the initial temperature of the object, and \( k \) is a constant.

\[
F(t) = F_s + (F_0 - F_s)e^{-kt}
\]

Coffee at a temperature of 195°F is poured into a container. The room temperature is kept at a constant 68°F and \( k = 0.05 \). Coffee is safe to drink when its temperature is, at most, 120°F. To the nearest minute, how long will it take until the coffee is safe to drink?

1) 7
2) 10
3) 11
4) 18

95 The average monthly high temperature in Buffalo, in degrees Fahrenheit, can be modeled by the function

\[
B(t) = 25.29\sin(0.4895t - 1.9752) + 55.2877,
\]

where \( t \) is the month number (January = 1). State, to the nearest tenth, the average monthly rate of temperature change between August and November. Explain its meaning in the given context.
96 A survey about television-viewing preferences was given to randomly selected freshmen and seniors at Fairport High School. The results are shown in the table below.

<table>
<thead>
<tr>
<th>Favorite Type of Program</th>
<th>Sports</th>
<th>Reality Show</th>
<th>Comedy Series</th>
</tr>
</thead>
<tbody>
<tr>
<td>Senior</td>
<td>83</td>
<td>110</td>
<td>67</td>
</tr>
<tr>
<td>Freshmen</td>
<td>119</td>
<td>103</td>
<td>54</td>
</tr>
</tbody>
</table>

A student response is selected at random from the results. State the exact probability the student response is from a freshman, given the student prefers to watch reality shows on television.

97 The results of simulating tossing a coin 10 times, recording the number of heads, and repeating this 50 times are shown in the graph below.

Based on the results of the simulation, which statement is false?
1) Five heads occurred most often, which is consistent with the theoretical probability of obtaining a heads.
2) Eight heads is unusual, as it falls outside the middle 95% of the data.
3) Obtaining three heads or fewer occurred 28% of the time.
4) Seven heads is not unusual, as it falls within the middle 95% of the data.

98 Solve the following system of equations algebraically. $x^2 + y^2 = 400$

\[ y = x - 28 \]

99 The solutions to the equation $5x^2 - 2x + 13 = 9$ are

\[
1 \) \quad \frac{1}{5} \pm \frac{\sqrt{21}}{5}
\]
\[
2 \) \quad \frac{1}{5} \pm \frac{\sqrt{19}}{5}i
\]
\[
3 \) \quad \frac{1}{5} \pm \frac{\sqrt{66}}{5}i
\]
\[
4 \) \quad \frac{1}{5} \pm \frac{\sqrt{66}}{5}
\]

100 The completely factored form of $n^4 - 9n^2 + 4n^3 - 36n - 12n^2 + 108$ is

\[
1 \) \quad (n^2 - 9)(n + 6)(n - 2)
\]
\[
2 \) \quad (n + 3)(n - 3)(n + 6)(n - 2)
\]
\[
3 \) \quad (n - 3)(n - 3)(n + 6)(n - 2)
\]
\[
4 \) \quad (n + 3)(n - 3)(n - 6)(n + 2)
\]

101 If $p(x) = 2x^3 - 3x + 5$, what is the remainder of $p(x) \div (x - 5)$?

\[
1 \) \quad -230
\]
\[
2 \) \quad 0
\]
\[
3 \) \quad 40
\]
\[
4 \) \quad 240
\]
102 Which sketch best represents the graph of $x = 3^y$?

1)  

2)  

3)  

4)  

103 The expression $(x + a)(x + b)$ can not be written as

1) $a(x + b) + x(x + b)$
2) $x^2 + abx + ab$
3) $x^2 + (a + b)x + ab$
4) $x(x + a) + b(x + a)$

104 If $f(x) = x^2 + 9$ and $g(x) = x + 3$, which operation would not result in a polynomial expression?

1) $f(x) + g(x)$
2) $f(x) - g(x)$
3) $f(x) \cdot g(x)$
4) $f(x) + g(x)$

105 Which situation could be modeled using a geometric sequence?

1) A cell phone company charges $30.00 per month for 2 gigabytes of data and $12.50 for each additional gigabyte of data.
2) The temperature in your car is 79°. You lower the temperature of your air conditioning by 2° every 3 minutes in order to find a comfortable temperature.
3) David’s parents have set a limit of 50 minutes per week that he may play online games during the school year. However, they will increase his time by 5% per week for the next ten weeks.
4) Sarah has $100.00 in her piggy bank and saves an additional $15.00 each week.

106 The expression $4\sqrt[4]{81x^8y^6}$ is equivalent to

1) $3x^2y^2$
2) $3x^4y^2$
3) $9x^2y^3$
4) $9x^4y^3$

107 Kenzie believes that for $x \geq 0$, the expression $\left(\frac{7}{\sqrt{x^2}}\right)\left(\frac{5}{\sqrt{x^3}}\right)$ is equivalent to $\frac{35}{\sqrt{x^6}}$. Is she correct? Justify your response algebraically.
108 The graph below represents national and New York State average gas prices.

If New York State's gas prices are modeled by \( G(x) \) and \( C > 0 \), which expression best approximates the national average \( x \) months from August 2014?

1) \( G(x + C) \)
2) \( G(x) + C \)
3) \( G(x - C) \)
4) \( G(x) - C \)

109 Given \( a(x) = x^4 + 2x^3 + 4x - 10 \) and \( b(x) = x + 2 \), determine \( \frac{a(x)}{b(x)} \) in the form \( q(x) + \frac{r(x)}{b(x)} \). Is \( b(x) \) a factor of \( a(x) \)? Explain.

110 Factor completely over the set of integers:
\[ 16x^4 - 81 \]. Sara graphed the polynomial \( y = 16x^4 - 81 \) and stated “All the roots of \( y = 16x^4 - 81 \) are real.” Is Sara correct? Explain your reasoning.

111 Judith puts $5000 into an investment account with interest compounded continuously. Which approximate annual rate is needed for the account to grow to $9110 after 30 years?

1) 2%
2) 2.2%
3) 0.02%
4) 0.022%

112 If the function \( g(x) = ab^x \) represents exponential growth, which statement about \( g(x) \) is false?

1) \( a > 0 \) and \( b > 1 \)
2) The \( y \)-intercept is \((0, a)\).
3) The asymptote is \( y = 0 \).
4) The \( x \)-intercept is \((b, 0)\).

113 The function \( N(t) = 100e^{-0.023t} \) models the number of grams in a sample of cesium-137 that remain after \( t \) years. On which interval is the sample's average rate of decay the fastest?

1) \([1, 10]\)
2) \([10, 20]\)
3) \([15, 25]\)
4) \([1, 30]\)

114 The scores on a mathematics college-entry exam are normally distributed with a mean of 68 and standard deviation 7.2. Students scoring higher than one standard deviation above the mean will not be enrolled in the mathematics tutoring program. How many of the 750 incoming students can be expected to be enrolled in the tutoring program?

1) 631
2) 512
3) 238
4) 119
Joseph was curious to determine if scent improves memory. A test was created where better memory is indicated by higher test scores. A controlled experiment was performed where one group was given the test on scented paper and the other group was given the test on unscented paper. The summary statistics from the experiment are given below.

<table>
<thead>
<tr>
<th>Scented Paper</th>
<th>Unscented Paper</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \bar{x} )</td>
<td>23</td>
</tr>
<tr>
<td>( s_x )</td>
<td>2.898</td>
</tr>
<tr>
<td></td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>2.408</td>
</tr>
</tbody>
</table>

Calculate the difference in means in the experimental test grades (scented - unscented). A simulation was conducted in which the subjects' scores were rerandomized into two groups 1000 times. The differences of the group means were calculated each time. The results are shown below.

Use the simulation results to determine the interval representing the middle 95% of the difference in means, to the nearest hundredth. Is the difference in means in Joseph's experiment statistically significant based on the simulation? Explain.
116 When a ball bounces, the heights of consecutive bounces form a geometric sequence. The height of the first bounce is 121 centimeters and the height of the third bounce is 64 centimeters. To the nearest centimeter, what is the height of the fifth bounce?

1) 25  
2) 34  
3) 36  
4) 42

117 For which values of \( x \), rounded to the nearest hundredth, will \( x^2 - 9 - 3 = \log_3 x \)?

1) 2.29 and 3.63  
2) 2.37 and 3.54  
3) 2.84 and 3.17  
4) 2.92 and 3.06

118 Robin flips a coin 100 times. It lands heads up 43 times, and she wonders if the coin is unfair. She runs a computer simulation of 750 samples of 100 fair coin flips. The output of the proportion of heads is shown below.

Do the results of the simulation provide strong evidence that Robin’s coin is unfair? Explain your answer.

119 At Andrew Jackson High School, students are only allowed to enroll in AP U.S. History if they have already taken AP World History or AP European History. Out of 825 incoming seniors, 165 took AP World History, 66 took AP European History, and 33 took both. Given this information, determine the probability a randomly selected incoming senior is allowed to enroll in AP U.S. History.

120 A study of black bears in the Adirondacks reveals that their population can be represented by the function \( P(t) = 3500(1.025)^t \), where \( t \) is the number of years since the study began. Which function is correctly rewritten to reveal the monthly growth rate of the black bear population?

1) \( P(t) = 3500(1.00206)^{12t} \)  
2) \( P(t) = 3500(1.00206)^{\frac{t}{12}} \)  
3) \( P(t) = 3500(1.34489)^{12t} \)  
4) \( P(t) = 3500(1.34489)^{\frac{t}{12}} \)

121 A savings account, \( S \), has an initial value of $50. The account grows at a 2% interest rate compounded \( n \) times per year, \( t \), according to the function below.

\[
S(t) = 50 \left(1 + \frac{0.02}{n}\right)^{nt}
\]

Which statement about the account is correct?

1) As the value of \( n \) increases, the amount of interest per year decreases.  
2) As the value of \( n \) increases, the value of the account approaches the function \( S(t) = 50e^{0.02t} \).  
3) As the value of \( n \) decreases to one, the amount of interest per year increases.  
4) As the value of \( n \) decreases to one, the value of the account approaches the function \( S(t) = 50(1 - 0.02)^t \).
122. The graph of \( y = f(x) \) is shown below.

Which expression defines \( f(x) \)?

1) \( 2x \)
2) \( 5(2^x) \)
3) \( \frac{x}{2} \)
4) \( 5(2^{2x}) \)

123. The zeros of a quartic polynomial function \( h \) are \(-1, \pm 2, \) and \(3\). Sketch a graph of \( y = h(x) \) on the grid below.

124. Which table best represents an exponential relationship?

1) \[
\begin{array}{c|c}
  x & y \\
  \hline
  1 & 8 \\
  2 & 4 \\
  3 & 2 \\
  4 & 1 \\
  5 & \frac{1}{2}
\end{array}
\]

2) \[
\begin{array}{c|c}
  x & y \\
  \hline
  0 & 0 \\
  4 & 1 \\
  0 & 2 \\
 -4 & 3 \\
 -8 & 4
\end{array}
\]

3) \[
\begin{array}{c|c}
  x & y \\
  \hline
  0 & 0 \\
  1 & 1 \\
  2 & 4 \\
  3 & 9 \\
  4 & 16
\end{array}
\]

4) \[
\begin{array}{c|c}
  x & y \\
  \hline
  1 & 1 \\
  2 & 8 \\
  3 & 27 \\
  4 & 64 \\
  5 & 125
\end{array}
\]
125 On the grid below, graph the function \( y = \log_2(x - 3) + 1 \)

126 A veterinary pharmaceutical company plans to test a new drug to treat a common intestinal infection among puppies. The puppies are randomly assigned to two equal groups. Half of the puppies will receive the drug, and the other half will receive a placebo. The veterinarians monitor the puppies. This is an example of which study method?
1) census  
2) observational study  
3) survey  
4) controlled experiment

127 The scores of a recent test taken by 1200 students had an approximately normal distribution with a mean of 225 and a standard deviation of 18. Determine the number of students who scored between 200 and 245.

128 If \( f(x) = \log_3 x \) and \( g(x) \) is the image of \( f(x) \) after a translation five units to the left, which equation represents \( g(x) \)?
1) \( g(x) = \log_3(x + 5) \)  
2) \( g(x) = \log_3 x + 5 \)  
3) \( g(x) = \log_3(x - 5) \)  
4) \( g(x) = \log_3 x - 5 \)

129 The weights of bags of Graseck's Chocolate Candies are normally distributed with a mean of 4.3 ounces and a standard deviation of 0.05 ounces. What is the probability that a bag of these chocolate candies weighs less than 4.27 ounces?
1) 0.2257  
2) 0.2743  
3) 0.7257  
4) 0.7757
130 Some smart-phone applications contain "in-app" purchases, which allow users to purchase special content within the application. A random sample of 140 users found that 35 percent made in-app purchases. A simulation was conducted with 200 samples of 140 users assuming 35 percent of the samples make in-app purchases. The approximately normal results are shown below.

Considering the middle 95% of the data, determine the margin of error, to the nearest hundredth, for the simulated results. In the given context, explain what this value represents.

131 Given \( f(x) = \frac{1}{2}x + 8 \), which equation represents the inverse, \( g(x) \)?
1) \( g(x) = 2x - 8 \)
2) \( g(x) = 2x - 16 \)
3) \( g(x) = -\frac{1}{2}x + 8 \)
4) \( g(x) = -\frac{1}{2}x - 16 \)

132 Write a recursive formula for the sequence 6, 9, 13.5, 20.25, . . .

133 What are the solution(s) to the system of equations shown below?
\[
\begin{align*}
x^2 + y^2 &= 5 \\
y &= 2x
\end{align*}
\]
1) \( x = 1 \) and \( x = -1 \)
2) \( x = 1 \)
3) \((1, 2)\) and \((-1, -2)\)
4) \((1, 2)\), only

134 Write \( -\frac{1}{2}i^3(\sqrt{-9} - 4) - 3i^2 \) in simplest \( a + bi \) form.
135 The populations of two small towns at the beginning of 2018 and their annual population growth rate are shown in the table below.

<table>
<thead>
<tr>
<th>Town</th>
<th>Population</th>
<th>Annual Population Growth Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jonesville</td>
<td>1240</td>
<td>6% increase</td>
</tr>
<tr>
<td>Williamstown</td>
<td>890</td>
<td>11% increase</td>
</tr>
</tbody>
</table>

Assuming the trend continues, approximately how many years after the beginning of 2018 will it take for the populations to be equal?
1) 7  
2) 20  
3) 68  
4) 125

136 Data for the students enrolled in a local high school are shown in the Venn diagram below.

If a student from the high school is selected at random, what is the probability that the student is a sophomore given that the student is enrolled in Algebra II?
1) \( \frac{85}{210} \)  
2) \( \frac{85}{295} \)  
3) \( \frac{85}{405} \)  
4) \( \frac{85}{1600} \)

137 For positive values of \( x \), which expression is equivalent to \( \sqrt{16x^2 \cdot \frac{2}{3} + 3\sqrt{8x^5}} \)?
1) \( 6\sqrt[5]{x^3} \)  
2) \( 6\sqrt[5]{x^5} \)  
3) \( 4\sqrt[5]{x^2} + 2\sqrt[5]{x^5} \)  
4) \( 4\sqrt[5]{x^3} + 2\sqrt[5]{x^3} \)

138 The hours of daylight, \( y \), in Utica in days, \( x \), from January 1, 2013 can be modeled by the equation \( y = 3.06\sin(0.017x - 1.40) + 12.23 \). How many hours of daylight, to the nearest tenth, does this model predict for February 14, 2013?
1) 9.4  
2) 10.4  
3) 12.1  
4) 12.2
139 The resting blood pressure of an adult patient can be modeled by the function $P$ below, where $P(t)$ is the pressure in millimeters of mercury after time $t$ in seconds.

$$P(t) = 24 \cos(3\pi t) + 120$$

On the set of axes below, graph $y = P(t)$ over the domain $0 \leq t \leq 2$.

Determine the period of $P$. Explain what this value represents in the given context. Normal resting blood pressure for an adult is 120 over 80. This means that the blood pressure oscillates between a maximum of 120 and a minimum of 80. Adults with high blood pressure (above 140 over 90) and adults with low blood pressure (below 90 over 60) may be at risk for health disorders. Classify the given patient's blood pressure as low, normal, or high and explain your reasoning.

140 Determine for which polynomial(s) $(x + 2)$ is a factor. Explain your answer.

$$P(x) = x^4 - 3x^3 - 16x - 12$$

$$Q(x) = x^3 - 3x^2 - 16x - 12$$

141 Which expression(s) are equivalent to $\frac{x^2 - 4x}{2x}$, where $x \neq 0$?

I. $\frac{x}{2} - 2$

II. $\frac{x - 4}{2}$

III. $\frac{x - 1}{2} - \frac{3}{2}$

1) II, only

2) I and II

3) II and III

4) I, II, and III

142 According to a study, 45% of Americans have type O blood. If a random number generator produces three-digit values from 000 to 999, which values would represent those having type O blood?

1) between 000 and 045, inclusive

2) between 000 and 444, inclusive

3) between 000 and 449, inclusive

4) between 000 and 450, inclusive

143 Carla wants to start a college fund for her daughter Lila. She puts $63,000 into an account that grows at a rate of 2.55% per year, compounded monthly. Write a function, $C(t)$, that represents the amount of money in the account $t$ years after the account is opened, given that no more money is deposited into or withdrawn from the account. Calculate algebraically the number of years it will take for the account to reach $100,000, to the nearest hundredth of a year.
144 Given \( x \neq -2 \), the expression \( \frac{2x^2 + 5x + 8}{x + 2} \) is equivalent to
1) \( 2x^2 + \frac{9}{x + 2} \)
2) \( 2x + \frac{7}{x + 2} \)
3) \( 2x + 1 + \frac{6}{x + 2} \)
4) \( 2x + 9 - \frac{10}{x + 2} \)

145 A sketch of \( r(x) \) is shown below.

147 Solve the following system of equations algebraically for all values of \( a, b, \) and \( c \).
\[
\begin{align*}
    a + 4b + 6c &= 23 \\
    a + 2b + c &= 2 \\
    6b + 2c &= a + 14
\end{align*}
\]

148 A 7-year lease for office space states that the annual rent is $85,000 for the first year and will increase by 6% each additional year of the lease. What will the total rent expense be for the entire 7-year lease?
1) $42,809.63
2) $90,425.53
3) $595,000.00
4) $713,476.20

149 Which value, to the nearest tenth, is the smallest solution of \( f(x) = g(x) \) if \( f(x) = 3 \sin \left( \frac{1}{2}x \right) - 1 \) and \( g(x) = x^3 - 2x + 1 \)?
1) \(-3.6\)
2) \(-2.1\)
3) \(-1.8\)
4) \(1.4\)

150 If \( x - 1 \) is a factor of \( x^3 - kx^2 + 2x \), what is the value of \( k \)?
1) \(0\)
2) \(2\)
3) \(3\)
4) \(-3\)
151 The half-life of iodine-131 is 8 days. The percent of the isotope left in the body \( d \) days after being introduced is \( I = 100 \left( \frac{1}{2} \right)^{\frac{d}{8}} \). When this equation is written in terms of the number \( e \), the base of the natural logarithm, it is equivalent to \( I = 100e^{kd} \). What is the approximate value of the constant, \( k \)?

1) \(-0.087\)
2) \(0.087\)
3) \(-11.542\)
4) \(11.542\)

152 The terminal side of \( \theta \), an angle in standard position, intersects the unit circle at \( P \left( -\frac{1}{3}, -\frac{\sqrt{8}}{3} \right) \). What is the value of sec \( \theta \)?

1) \(-3\)
2) \(3\sqrt{8}/8\)
3) \(1/3\)
4) \(\sqrt{8}/3\)

153 Stephanie found that the number of white-winged cross bills in an area can be represented by the formula \( C = 550(1.08)^t \), where \( t \) represents the number of years since 2010. Which equation correctly represents the number of white-winged cross bills in terms of the monthly rate of population growth?

1) \( C = 550(1.00643)^t \)
2) \( C = 550(1.00643)^{12t} \)
3) \( C = 550(1.00643)^{t/12} \)
4) \( C = 550(1.00643)^{t+12} \)

154 Savannah just got contact lenses. Her doctor said she can wear them 2 hours the first day, and can then increase the length of time by 30 minutes each day. If this pattern continues, which formula would not be appropriate to determine the length of time, in either minutes or hours, she could wear her contact lenses on the \( n \)th day?

1) \( a_1 = 120 \)
2) \( a_n = 90 + 30n \)
3) \( a_1 = 2 \)
4) \( a_n = 2.5 + 0.5n \)

155 If a solution of \( 2(2x - 1) = 5x^2 \) is expressed in simplest \( a + bi \) form, the value of \( b \) is

1) \( \frac{\sqrt{6}}{5} i \)
2) \( \frac{\sqrt{6}}{5} \)
3) \( \frac{1}{5} i \)
4) \( \frac{1}{5} \)

156 On July 21, 2016, the water level in Puget Sound, WA reached a high of 10.1 ft at 6 a.m. and a low of -2 ft at 12:30 p.m. Across the country in Long Island, NY, Shinnecock Bay’s water level reached a high of 2.5 ft at 10:42 p.m. and a low of -0.1 ft at 5:31 a.m. The water levels of both locations are affected by the tides and can be modeled by sinusoidal functions. Determine the difference in amplitudes, in feet, for these two locations.
157 A manufacturing plant produces two different-sized containers of peanuts. One container weighs \( x \) ounces and the other weighs \( y \) pounds. If a gift set can hold one of each size container, which expression represents the number of gift sets needed to hold 124 ounces?

1) \( \frac{124}{16x + y} \)
2) \( \frac{x + 16y}{124} \)
3) \( \frac{124}{x + 16y} \)
4) \( \frac{16x + y}{124} \)

158 Suppose two sets of test scores have the same mean, but different standard deviations, \( \sigma_1 \) and \( \sigma_2 \), with \( \sigma_2 > \sigma_1 \). Which statement best describes the variability of these data sets?

1) Data set one has the greater variability.
2) Data set two has the greater variability.
3) The variability will be the same for each data set.
4) No conclusion can be made regarding the variability of either set.

159 Which function's graph has a period of 8 and reaches a maximum height of 1 if at least one full period is graphed?

1) \( y = -4 \cos \left( \frac{\pi}{4} x \right) - 3 \)
2) \( y = -4 \cos \left( \frac{\pi}{4} x \right) + 5 \)
3) \( y = -4 \cos(5x) - 3 \)
4) \( y = -4 \cos(5x) + 5 \)

160 The parabola described by the equation \( y = \frac{1}{12} (x - 2)^2 + 2 \) has the directrix at \( y = -1 \). The focus of the parabola is

1) (2, -1)
2) (2, 2)
3) (2, 3)
4) (2, 5)

161 The zeros of a quartic polynomial function are 2, \(-2\), 4, and \(-4\). Use the zeros to construct a possible sketch of the function, on the set of axes below.

162 Emmeline is working on one side of a polynomial identity proof used to form Pythagorean triples. Her work is shown below:

\[
(5x)^2 + (5x^2 - 5)^2
\]

Step 1: \( 25x^2 + (5x^2 - 5)^2 \)
Step 2: \( 25x^2 + 25x^2 + 25 \)
Step 3: \( 50x^2 + 25 \)
Step 4: \( 75x^2 \)

What statement is true regarding Emmeline's work?

1) Emmeline's work is entirely correct.
2) There is a mistake in step 2, only.
3) There are mistakes in step 2 and step 4.
4) There is a mistake in step 4, only.
163 After Roger’s surgery, his doctor administered pain medication in the following amounts in milligrams over four
days.

<table>
<thead>
<tr>
<th>Day (n)</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dosage (m)</td>
<td>2000</td>
<td>1680</td>
<td>1411.2</td>
<td>1185.4</td>
</tr>
</tbody>
</table>

How can this sequence best be modeled recursively?
1) \( m_1 = 2000 \)  
2) \( m_n = 2000(0.84)^{n-1} \)  
3) \( m_1 = 2000 \)  
4) \( m_n = 2000(0.84)^{n+1} \)

164 Consider the data in the table below.

<table>
<thead>
<tr>
<th>Sex</th>
<th>Right Handed</th>
<th>Left Handed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>87</td>
<td>13</td>
</tr>
<tr>
<td>Female</td>
<td>89</td>
<td>11</td>
</tr>
</tbody>
</table>

What is the probability that a randomly selected person is male given the person is left handed?
1) \( \frac{13}{200} \)  
2) \( \frac{13}{100} \)  
3) \( \frac{13}{50} \)  
4) \( \frac{13}{24} \)

165 A recursive formula for the sequence
40,30,22.5,\ldots is

1) \( g_n = 40 \left( \frac{3}{4} \right)^n \)  
2) \( g_1 = 40 \)  
3) \( g_n = g_{n-1} - 10 \)  
4) \( g_1 = 40 \)  
5) \( g_n = \frac{3}{4} g_{n-1} \)

166 The average monthly temperature of a city can be modeled by a cosine graph. Melissa has been
living in Phoenix, Arizona, where the average annual temperature is 75°F. She would like to
move, and live in a location where the average annual temperature is 62°F. When examining the
graphs of the average monthly temperatures for various locations, Melissa should focus on the
1) amplitude  
2) horizontal shift  
3) period  
4) midline
167 Determine an equation for the parabola with focus (4, -1) and directrix \( y = -5 \). (Use of the grid below is optional.)

168 There are 440 students at Thomas Paine High School enrolled in U.S. History. On the April report card, the students' grades are approximately normally distributed with a mean of 79 and a standard deviation of 7. Students who earn a grade less than or equal to 64.9 must attend summer school. The number of students who must attend summer school for U.S. History is closest to

1) 3
2) 5
3) 10
4) 22

169 Which function is even?
1) \( f(x) = \sin x \)
2) \( f(x) = x^2 - 4 \)
3) \( f(x) = |x - 2| + 5 \)
4) \( f(x) = x^4 + 3x^3 + 4 \)

170 What is the inverse of \( f(x) = x^3 - 2 \)?
1) \( f^{-1}(x) = \frac{1}{3}x + 2 \)
2) \( f^{-1}(x) = \pm \sqrt[3]{x} + 2 \)
3) \( f^{-1}(x) = \sqrt[3]{x} + 2 \)
4) \( f^{-1}(x) = \pm \sqrt[3]{x} + 2 \)

171 The expression \( \frac{9x^2 - 2}{3x + 1} \) is equivalent to
1) \( 3x - 1 - \frac{1}{3x + 1} \)
2) \( 3x - 1 + \frac{1}{3x + 1} \)
3) \( 3x + 1 - \frac{1}{3x + 1} \)
4) \( 3x + 1 + \frac{1}{3x + 1} \)

172 The probability that a resident of a housing community opposes spending money for community improvement on plumbing issues is 0.8. The probability that a resident favors spending money on improving walkways given that the resident opposes spending money on plumbing issues is 0.85. Determine the probability that a randomly selected resident opposes spending money on plumbing issues and favors spending money on walkways.

173 Which expression is not a solution to the equation \( 2^t = \sqrt[3]{10} \)?
1) \( \frac{1}{2} \log_2 10 \)
2) \( \log_2 \sqrt[3]{10} \)
3) \( \log_4 10 \)
4) \( \log_{10} 4 \)
174 Which description could represent the graph of 
\( f(x) = 4x^2(x + a) - x - a \), if \( a \) is an integer?
1) As \( x \to -\infty \), \( f(x) \to \infty \), as \( x \to \infty \), \( f(x) \to \infty \), and the graph has 3 \( x \)-intercepts.
2) As \( x \to -\infty \), \( f(x) \to -\infty \), as \( x \to \infty \), \( f(x) \to -\infty \), and the graph has 3 \( x \)-intercepts.
3) As \( x \to -\infty \), \( f(x) \to \infty \), as \( x \to \infty \), \( f(x) \to -\infty \), and the graph has 4 \( x \)-intercepts.
4) As \( x \to -\infty \), \( f(x) \to -\infty \), as \( x \to \infty \), \( f(x) \to \infty \), and the graph has 4 \( x \)-intercepts.

175 Consider the end behavior description below.
• as \( x \to -\infty \), \( f(x) \to \infty \)
• as \( x \to \infty \), \( f(x) \to -\infty \)
Which function satisfies the given conditions?
1) \( f(x) = x^4 + 2x^2 + 1 \)
2) \( f(x) = -x^3 + 2x - 6 \)

176 Evaluate \( j(-1) \) given
\( j(x) = 2x^4 - x^3 - 35x^2 + 16x + 48 \). Explain what your answer tells you about \( x + 1 \) as a factor. Algebraically find the remaining zeros of \( j(x) \).

177 Write an equation for a sine function with an amplitude of 2 and a period of \( \frac{\pi}{2} \). On the grid below, sketch the graph of the equation in the interval 0 to 2\( \pi \).

178 The function below models the average price of gas in a small town since January 1st.
\( G(t) = -0.0049t^4 + 0.0923t^3 - 0.56t^2 + 1.166t + 3.23 \), where \( 0 \leq t \leq 10 \).
If \( G(t) \) is the average price of gas in dollars and \( t \) represents the number of months since January 1st, the absolute maximum \( G(t) \) reaches over the given domain is about
1) $1.60
2) $3.92
3) $4.01
4) $7.73

179 Solve the given equation algebraically for all values of \( x \).
\[ 3\sqrt{x} - 2x = -5 \]
180 The Wells family is looking to purchase a home in a suburb of Rochester with a 30-year mortgage that has an annual interest rate of 3.6%. The house the family wants to purchase is $152,500 and they will make a $15,250 down payment and borrow the remainder. Use the formula below to determine their monthly payment, to the nearest dollar.

\[
M = \frac{P \left( \frac{r}{12} \right) \left( 1 + \frac{r}{12} \right)^n}{\left( 1 + \frac{r}{12} \right)^n - 1}
\]

- \(M\) = monthly payment
- \(P\) = amount borrowed
- \(r\) = annual interest rate
- \(n\) = total number of monthly payments

181 Erin and Christa were working on cubing binomials for math homework. Erin believed they could save time with a shortcut. She wrote down the rule below for Christa to follow.

\[(a + b)^3 = a^3 + b^3\]

Does Erin's shortcut always work? Justify your result algebraically.

182 What is the solution set of the equation

\[
\frac{2}{x} - \frac{3x}{x+3} = \frac{x}{x+3}
\]

1) \{3\}
2) \{\frac{3}{2}\}
3) \{-2, 3\}
4) \{-1, \frac{3}{2}\}

183 A student is chosen at random from the student body at a given high school. The probability that the student selects Math as the favorite subject is \(\frac{1}{4}\). The probability that the student chosen is a junior is \(\frac{116}{459}\). If the probability that the student selected is a junior or that the student chooses Math as the favorite subject is \(\frac{47}{108}\), what is the exact probability that the student selected is a junior whose favorite subject is Math? Are the events "the student is a junior" and "the student's favorite subject is Math" independent of each other? Explain your answer.

184 Sketch the graphs of \(r(x) = \frac{1}{x}\) and \(a(x) = |x| - 3\) on the set of axes below. Determine, to the nearest tenth, the positive solution of \(r(x) = a(x)\).
185 The Beaufort Wind Scale was devised by British Rear Admiral Sir Francis Beaufort, in 1805 based upon observations of the effects of the wind. Beaufort numbers, $B$, are determined by the equation

$$B = 1.69 \sqrt{s} + 4.45 - 3.49,$$

where $s$ is the speed of the wind in mph, and $B$ is rounded to the nearest integer from 0 to 12.

<table>
<thead>
<tr>
<th>Beaufort Wind Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beaufort Number</td>
</tr>
<tr>
<td>---------------------</td>
</tr>
<tr>
<td>0</td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>2</td>
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<tr>
<td>3</td>
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<td>10</td>
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<tr>
<td>11</td>
</tr>
<tr>
<td>12</td>
</tr>
</tbody>
</table>

Using the table above, classify the force of wind at a speed of 30 mph. Justify your answer. In 1946, the scale was extended to accommodate strong hurricanes. A strong hurricane received a $B$ value of exactly 15. Algebraically determine the value of $s$, to the nearest mph. Any $B$ values that round to 10 receive a Beaufort number of 10. Using technology, find an approximate range of wind speeds, to the nearest mph, associated with a Beaufort number of 10.

186 For all values of $x$ for which the expression is defined, $\frac{x^3 + 2x^2 - 9x - 18}{x^3 - x^2 - 6x}$, in simplest form, is equivalent to

1) $3$
2) $\frac{17}{2}$
3) $\frac{x + 3}{x}$
4) $\frac{x^2 - 9}{x(x - 3)}$

187 After examining the functions $f(x) = \ln(x + 2)$ and $g(x) = e^{x-1}$ over the interval $(−2, 3]$, Lexi determined that the correct number of solutions to the equation $f(x) = g(x)$ is

1) 1
2) 2
3) 3
4) 0
188 Tony is evaluating his retirement savings. He currently has $318,000 in his account, which earns an interest rate of 7% compounded annually. He wants to determine how much he will have in the account in the future, even if he makes no additional contributions to the account. Write a function, $A(t)$, to represent the amount of money that will be in his account in $t$ years. Graph $A(t)$ where $0 \leq t \leq 20$ on the set of axes below.

Tony's goal is to save $1,000,000. Determine algebraically, to the nearest year, how many years it will take for him to achieve his goal. Explain how your graph of $A(t)$ confirms your answer.

189 Which situation best describes conditional probability?

1) finding the probability of an event occurring two or more times
2) finding the probability of an event occurring only once
3) finding the probability of two independent events occurring at the same time
4) finding the probability of an event occurring given another event had already occurred

190 A major car company analyzes its revenue, $R(x)$, and costs $C(x)$, in millions of dollars over a fifteen-year period. The company represents its revenue and costs as a function of time, in years, $x$, using the given functions.

\[
R(x) = 550x^3 - 12,000x^2 + 83,000x + 7000
\]
\[
C(x) = 880x^3 - 21,000x^2 + 150,000x - 160,000
\]

The company's profits can be represented as the difference between its revenue and costs. Write the profit function, $P(x)$, as a polynomial in standard form. Graph $y = P(x)$ on the set of axes below over the domain $2 \leq x \leq 16$.

Over the given domain, state when the company was the least profitable and the most profitable, to the nearest year. Explain how you determined your answer.

191 Algebraically solve for $x$:

\[
\frac{-3}{x + 3} + \frac{1}{2} = \frac{x}{6} - \frac{1}{2}
\]
192 If \( f(x) = a^x \) where \( a > 1 \), then the inverse of the function is
1) \( f^{-1}(x) = \log_a a \)
2) \( f^{-1}(x) = a \log x \)
3) \( f^{-1}(x) = \log_a x \)
4) \( f^{-1}(x) = x \log a \)

193 In a random sample of 250 men in the United States, age 21 or older, 139 are married. The graph below simulated samples of 250 men, 200 times, assuming that 139 of the men are married.

194 Consider the probability statements regarding events \( A \) and \( B \) below.
\[
P(A \text{ or } B) = 0.3; \quad P(A \text{ and } B) = 0.2; \quad \text{and} \quad P(A|B) = 0.8
\]
What is \( P(B) \)?
1) 0.1
2) 0.25
3) 0.375
4) 0.667

195 What is the inverse of \( f(x) = \frac{x}{x+2} \), where \( x \neq -2 \)?
1) \( f^{-1}(x) = \frac{2x}{x-1} \)
2) \( f^{-1}(x) = \frac{-2x}{x-1} \)
3) \( f^{-1}(x) = \frac{x}{x-2} \)
4) \( f^{-1}(x) = \frac{-x}{x-2} \)

196 If \( \cos \theta = -\frac{3}{4} \) and \( \theta \) is in Quadrant III, then \( \sin \theta \) is equivalent to
1) \( -\frac{\sqrt{7}}{4} \)
2) \( \frac{\sqrt{7}}{4} \)
3) \( -\frac{5}{4} \)
4) \( \frac{5}{4} \)

a) Based on the simulation, create an interval in which the middle 95% of the number of married men may fall. Round your answer to the nearest integer.
b) A study claims "50 percent of men 21 and older in the United States are married." Do your results from part a contradict this claim? Explain.
197 Irma initially ran one mile in over ten minutes. She then began a training program to reduce her one-mile time. She recorded her one-mile time once a week for twelve consecutive weeks, as modeled in the graph below.

Which statement regarding Irma’s one-mile training program is correct?
1) Her one-mile speed increased as the number of weeks increased.
2) Her one-mile speed decreased as the number of weeks increased.
3) If the trend continues, she will run under a six-minute mile by week thirteen.
4) She reduced her one-mile time the most between weeks ten and twelve.

198 Given \( P(x) = x^3 - 3x^2 - 2x + 4 \), which statement is true?
1) \((x - 1)\) is a factor because \( P(-1) = 2 \).
2) \((x + 1)\) is a factor because \( P(-1) = 2 \).
3) \((x + 1)\) is a factor because \( P(1) = 0 \).
4) \((x - 1)\) is a factor because \( P(1) = 0 \).

199 The J& B candy company claims that 45% of the candies it produces are blue, 30% are brown, and 25% are yellow. Each bag holds 65 candies. A simulation was run 200 times, each of sample size 65, based on the premise that 45% of the candies are blue. The results of the simulation are shown below.

Bonnie purchased a bag of J& B's candy and counted 24 blue candies. What inference can be made regarding a bag of J& B's with only 24 blue candies?
1) The company is not meeting their production standard.
2) Bonnie's bag was a rarity and the company should not be concerned.
3) The company should change their claim to 37% blue candies are produced.
4) Bonnie's bag is within the middle 95% of the simulated data supporting the company's claim.

200 Which expression is equivalent to \((2x - i)^2 - (2x - i)(2x + 3i)\) where \(i\) is the imaginary unit and \(x\) is a real number?
1) \(-4 - 8xi\)
2) \(-4 - 4xi\)
3) \(2\)
4) \(8x - 4i\)
201 The table below shows the number of hours of daylight on the first day of each month in Rochester, NY.

<table>
<thead>
<tr>
<th>Month</th>
<th>Hours of Daylight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan.</td>
<td>9.4</td>
</tr>
<tr>
<td>Feb.</td>
<td>10.6</td>
</tr>
<tr>
<td>March</td>
<td>11.9</td>
</tr>
<tr>
<td>April</td>
<td>13.9</td>
</tr>
<tr>
<td>May</td>
<td>14.7</td>
</tr>
<tr>
<td>June</td>
<td>15.4</td>
</tr>
<tr>
<td>July</td>
<td>15.1</td>
</tr>
<tr>
<td>Aug.</td>
<td>13.9</td>
</tr>
<tr>
<td>Sept.</td>
<td>12.5</td>
</tr>
<tr>
<td>Oct.</td>
<td>11.1</td>
</tr>
<tr>
<td>Nov.</td>
<td>9.7</td>
</tr>
<tr>
<td>Dec.</td>
<td>9.0</td>
</tr>
</tbody>
</table>

Given the data, what is the average rate of change in hours of daylight per month from January 1st to April 1st? Interpret what this means in the context of the problem.

202 The function $f(x) = a \cos bx + c$ is plotted on the graph shown below.

![Graph](image)

What are the values of $a$, $b$, and $c$?
1) $a = 2$, $b = 6$, $c = 3$
2) $a = 2$, $b = 3$, $c = 1$
3) $a = 4$, $b = 6$, $c = 5$
4) $a = 4$, $b = \frac{\pi}{3}$, $c = 3$

203 If $A = -3 + 5i$, $B = 4 - 2i$, and $C = 1 + 6i$, where $i$ is the imaginary unit, then $A - BC$ equals
1) $5 - 17i$
2) $5 + 27i$
3) $-19 - 17i$
4) $-19 + 27i$

204 How many solutions exist for
\[
\frac{1}{1 - x^2} = -|3x - 2| + 5?
\]
1) 1
2) 2
3) 3
4) 4

205 Over the set of integers, factor the expression
\[x^4 - 4x^2 - 12.\]
206 A random sample of 100 people that would best estimate the proportion of all registered voters in a district who support improvements to the high school football field should be drawn from registered voters in the district at a
1) football game
2) supermarket
3) school fund-raiser
4) high school band concert

207 A population of 950 bacteria grows continuously at a rate of 4.75% per day. Write an exponential function, \( N(t) \), that represents the bacterial population after \( t \) days and explain the reason for your choice of base. Determine the bacterial population after 36 hours, to the nearest bacterium.

208 Chuck's Trucking Company has decided to initiate an Employee of the Month program. To determine the recipient, they put the following sign on the back of each truck.

How's My Driving?
Call 1-555-DRIVING

The driver who receives the highest number of positive comments will win the recognition. Explain one statistical bias in this data collection method.

209 As \( \theta \) increases from \(-\frac{\pi}{2}\) to 0 radians, the value of \( \cos \theta \) will
1) decrease from 1 to 0
2) increase from 0 to 1
3) increase from 0 to 1
4) decrease from 0 to 1

210 The depth of the water at a marker 20 feet from the shore in a bay is depicted in the graph below.

![Graph of depth vs. time]

If the depth, \( d \), is measured in feet and time, \( t \), is measured in hours since midnight, what is an equation for the depth of the water at the marker?

1) \( d = 5 \cos \left( \frac{\pi}{6} t \right) + 9 \)
2) \( d = 9 \cos \left( \frac{\pi}{6} t \right) + 5 \)
3) \( d = 9 \sin \left( \frac{\pi}{6} t \right) + 5 \)
4) \( d = 5 \sin \left( \frac{\pi}{6} t \right) + 9 \)
Website popularity ratings are often determined using models that incorporate the number of visits per week a website receives. One model for ranking websites is \( P(x) = \log(x - 4) \), where \( x \) is the number of visits per week in thousands and \( P(x) \) is the website's popularity rating. According to this model, if a website is visited 16,000 times in one week, what is its popularity rating, rounded to the nearest tenth? Graph \( y = P(x) \) on the axes below.

An alternative rating model is represented by \( R(x) = \frac{1}{2} x - 6 \), where \( x \) is the number of visits per week in thousands. Graph \( R(x) \) on the same set of axes. For what number of weekly visits will the two models provide the same rating?

Tides are a periodic rise and fall of ocean water. On a typical day at a seaport, to predict the time of the next high tide, the most important value to have would be the
1) time between consecutive low tides
2) time when the tide height is 20 feet
3) average depth of water over a 24-hour period
4) difference between the water heights at low and high tide

Rowan is training to run in a race. He runs 15 miles in the first week, and each week following, he runs 3% more than the week before. Using a geometric series formula, find the total number of miles Rowan runs over the first ten weeks of training, rounded to the nearest thousandth.
214 Solve the equation $2x^2 + 5x + 8 = 0$. Express the answer in $a + bi$ form.

215 Chet has $1200 invested in a bank account modeled by the function $P(n) = 1200(1.002)^n$, where $P(n)$ is the value of his account, in dollars, after $n$ months. Chet's debt is modeled by the function $Q(n) = 100n$, where $Q(n)$ is the value of debt, in dollars, after $n$ months. After $n$ months, which function represents Chet's net worth, $R(n)$?

1) $R(n) = 1200(1.002)^n + 100n$
2) $R(n) = 1200(1.002)^{12n} + 100n$
3) $R(n) = 1200(1.002)^n - 100n$
4) $R(n) = 1200(1.002)^{12n} - 100n$

216 Graph $t(x) = 3 \sin(2x) + 2$ over the domain $[0, 2\pi]$ on the set of axes below.

217 The height above ground for a person riding a Ferris wheel after $t$ seconds is modeled by $h(t) = 150 \sin \left( \frac{\pi}{45} t + 67.5 \right) + 160$ feet. How many seconds does it take to go from the bottom of the wheel to the top of the wheel?

1) 10
2) 45
3) 90
4) 150

218 The world population was 2560 million people in 1950 and 3040 million in 1960 and can be modeled by the function $p(t) = 2560e^{0.017185t}$, where $t$ is time in years after 1950 and $p(t)$ is the population in millions. Determine the average rate of change of $p(t)$ in millions of people per year, from $4 \leq t \leq 8$. Round your answer to the nearest hundredth.

219 A certain pain reliever is taken in 220 mg dosages and has a half-life of 12 hours. The function $A = 220 \left( \frac{1}{2} \right)^{\frac{t}{12}}$ can be used to model this situation, where $A$ is the amount of pain reliever in milligrams remaining in the body after $t$ hours. According to this function, which statement is true?

1) Every hour, the amount of pain reliever remaining is cut in half.
2) In 12 hours, there is no pain reliever remaining in the body.
3) In 24 hours, there is no pain reliever remaining in the body.
4) In 12 hours, 110 mg of pain reliever is remaining.
220 Which graph represents a polynomial function that contains $x^2 + 2x + 1$ as a factor?

221 What is the inverse of $f(x) = -6(x - 2)$?

1) $f^{-1}(x) = -2 - \frac{x}{6}$
2) $f^{-1}(x) = 2 - \frac{x}{6}$
3) $f^{-1}(x) = \frac{1}{-6(x - 2)}$
4) $f^{-1}(x) = 6(x + 2)$

222 The equation $t = \frac{1}{0.0105} \ln \left( \frac{A}{5000} \right)$ relates time, $t$, in years, to the amount of money, $A$, earned by a $5000 investment. Which statement accurately describes the relationship between the average rates of change of $t$ on the intervals $[6000, 8000]$ and $[9000, 12,000]$?

1) A comparison cannot be made because the intervals are different sizes.
2) The average rate of change is equal for both intervals.
3) The average rate of change is larger for the interval $[6000, 8000]$.
4) The average rate of change is larger for the interval $[9000, 12,000]$.

223 Which statement is true about the graph of $f(x) = \left( \frac{1}{8} \right)^x$?

1) The graph is always increasing.
2) The graph is always decreasing.
3) The graph passes through $(1,0)$.
4) The graph has an asymptote, $x = 0$. 
224 Determine the quotient and remainder when 
\[(6a^3 + 11a^2 - 4a - 9)\] is divided by \((3a - 2)\).
Express your answer in the form \(q(a) + \frac{r(a)}{d(a)}\).

225 Which expression can be rewritten as 
\((x + 7)(x - 1)\)?
1) \((x + 3)^2 - 16\)
2) \((x + 3)^2 - 10(x + 3) - 2(x + 3) + 20\)
3) \(\frac{(x - 1)(x^2 - 6x - 7)}{(x + 1)}\)
4) \(\frac{(x + 7)(x^2 + 4x + 3)}{(x + 3)}\)

226 a) Algebraically determine the roots, in simplest 
\(a + bi\) form, to the equation below.
\[x^2 - 2x + 7 = 4x - 10\]
b) Consider the system of equations below.
\[y = x^2 - 2x + 7\]
\[y = 4x - 10\]
The graph of this system confirms the solution from part \(a\) is imaginary. Explain why.

227 A researcher randomly divides 50 bean plants into 
two groups. He puts one group by a window to 
receive natural light and the second group under 
artificial light. He records the growth of the plants 
weekly. Which data collection method is described 
in this situation?
1) observational study
2) controlled experiment
3) survey
4) systematic sample

228 The function \(N(x) = 90(0.86)^x + 69\) can be used to 
predict the temperature of a cup of hot chocolate in 
degrees Fahrenheit after \(x\) minutes. What is the 
approximate average rate of change of the 
temperature of the hot chocolate, in degrees per 
minute, over the interval \([0,6]\)?
1) \(-8.93\)
2) \(-0.11\)
3) \(0.11\)
4) \(8.93\)

229 Express the fraction \(\frac{3}{16x^4} \frac{2x^2}{4}\) in simplest radical 
form.

230 A person’s lung capacity can be modeled by the 
function \(C(t) = 250 \sin \left(\frac{2\pi}{5} t\right) + 2450\), where \(C(t)\) 
represents the volume in mL present in the lungs 
after \(t\) seconds. State the maximum value of this 
function over one full cycle, and explain what this 
value represents.

231 Given \(c(m) = m^3 - 2m^2 + 4m - 8\), the solution of 
\(c(m) = 0\) is
1) \(\pm 2\)
2) \(2\), only
3) \(2i, 2\)
4) \(\pm 2i, 2\)
232 Which statement(s) are true for all real numbers?

I \((x - y)^2 = x^2 + y^2\)

II \((x + y)^3 = x^3 + 3xy + y^3\)

1) I, only
2) II, only
3) I and II
4) neither I nor II

233 Consider the system of equations below:

\[
\begin{align*}
x + y - z &= 6 \\
2x - 3y + 2z &= -19 \\
-x + 4y - z &= 17
\end{align*}
\]

Which number is not the value of any variable in the solution of the system?

1) \(-1\)
2) 2
3) 3
4) \(-4\)

234 What is the solution set of \(x = \sqrt{3x + 40}\)?

1) \{-5, 8\}
2) \{8\}
3) \{-4, 10\}
4) \{\}

235 A sociologist reviews randomly selected surveillance videos from a public park over a period of several years and records the amount of time people spent on a smartphone. The statistical procedure the sociologist used is called

1) a census
2) an experiment
3) an observational study
4) a sample survey

236 A 4th degree polynomial has zeros \(-5, 3, i, \) and \(-i\). Which graph could represent the function defined by this polynomial?
237 Given \( \tan \theta = \frac{7}{24} \), and \( \theta \) terminates in Quadrant III, determine the value of \( \cos \theta \).

238 If \( n = \sqrt{a^5} \) and \( m = a \), where \( a > 0 \), an expression for \( \frac{n}{m} \) could be

1) \( \sqrt{a^2} \)
2) \( a^4 \)
3) \( \sqrt[3]{a^2} \)
4) \( \sqrt{a^5} \)

239 Given \( y > 0 \), the expression \( \sqrt{3x^2y} \cdot \sqrt[3]{27x^3y^2} \) is equivalent to

1) \( 81x^5y^3 \)
2) \( 3^{1.5}x^2y \)
3) \( \frac{5}{3}x^2y^{\frac{5}{2}} \)
4) \( 3^{\frac{1}{3}}x^2y^{\frac{5}{6}} \)

240 On a given school day, the probability that Nick oversleeps is 48% and the probability he has a pop quiz is 25%. Assuming these two events are independent, what is the probability that Nick oversleeps and has a pop quiz on the same day?

1) 73%
2) 36%
3) 23%
4) 12%

241 The recursive formula to describe a sequence is shown below.

\[ a_1 = 3 \]
\[ a_n = 1 + 2a_{n-1} \]

State the first four terms of this sequence. Can this sequence be represented using an explicit geometric formula? Justify your answer.

242 Graph \( f(x) = \log_2(x + 6) \) on the set of axes below.

243 Which statement regarding polynomials and their zeros is true?

1) \( f(x) = (x^2 - 1)(x + a) \) has zeros of 1 and \(-a\), only.
2) \( f(x) = x^3 - ax^2 + 16x - 16a \) has zeros of 4 and \(a\), only.
3) \( f(x) = (x^2 + 25)(x + a) \) has zeros of \(\pm 5\) and \(-a\).
4) \( f(x) = x^3 - ax^2 - 9x + 9a \) has zeros of \(\pm 3\) and \(a\).
244. On the grid below, graph the function \( f(x) = x^3 - 6x^2 + 9x + 6 \) on the domain \(-1 \leq x \leq 4\).

245. Completely factor the following expression:
\[ x^2 + 3xy + 3x^3 + y \]

246. The operator of the local mall wants to find out how many of the mall's employees make purchases in the food court when they are working. She hopes to use these data to increase the rent and attract new food vendors. In total, there are 1023 employees who work at the mall. The best method to obtain a random sample of the employees would be to survey
1) all 170 employees at each of the larger stores
2) 50% of the 90 employees of the food court
3) every employee
4) every 30th employee entering each mall entrance for one week

247. Solve algebraically for all values of \( x \):
\[ \sqrt{x - 5} + x = 7 \]

248. Which diagram represents an angle, \( \alpha \), measuring \( \frac{13\pi}{20} \) radians drawn in standard position, and its reference angle, \( \theta \)?
249 The lifespan of a 60-watt lightbulb produced by a company is normally distributed with a mean of 1450 hours and a standard deviation of 8.5 hours. If a 60-watt lightbulb produced by this company is selected at random, what is the probability that its lifespan will be between 1440 and 1465 hours?

1) 0.3803  
2) 0.4612  
3) 0.8415  
4) 0.9612

250 On the axes below, graph one cycle of a cosine function with amplitude 3, period $\frac{\pi}{2}$, midline $y = -1$, and passing through the point (0,2).

251 Use the properties of rational exponents to determine the value of $y$ for the equation:

$$\frac{\sqrt[\lambda]{x^8}}{\frac{1}{3}} = x^y, \quad x > 1$$

252 A candidate for political office commissioned a poll. His staff received responses from 900 likely voters and 55% of them said they would vote for the candidate. The staff then conducted a simulation of 1000 more polls of 900 voters, assuming that 55% of voters would vote for their candidate. The output of the simulation is shown in the diagram below.

Given this output, and assuming a 95% confidence level, the margin of error for the poll is closest to

1) 0.01  
2) 0.03  
3) 0.06  
4) 0.12
253 Sonja is cutting wire to construct a mobile. She cuts 100 inches for the first piece, 80 inches for the second piece, and 64 inches for the third piece. Assuming this pattern continues, write an explicit equation for \( a_n \), the length in inches of the \( n \)th piece. Sonja only has 40 feet of wire to use for the project and wants to cut 20 pieces total for the mobile using her pattern. Will she have enough wire? Justify your answer.

254 Given the parent function \( p(x) = \cos x \), which phrase best describes the transformation used to obtain the graph of \( g(x) = \cos(x + a) - b \), if \( a \) and \( b \) are positive constants?
1) right \( a \) units, up \( b \) units
2) right \( a \) units, down \( b \) units
3) left \( a \) units, up \( b \) units
4) left \( a \) units, down \( b \) units

255 Which statement regarding the graphs of the functions below is untrue?
\( f(x) = 3 \sin 2x \), from \(-\pi < x < \pi\)
\( g(x) = (x - 0.5)(x + 4)(x - 2) \)
\( h(x) = \log_2 x \)
\( j(x) = -|4x - 2| + 3 \)
1) \( f(x) \) and \( j(x) \) have a maximum \( y \)-value of 3.
2) \( f(x) \), \( h(x) \), and \( j(x) \) have one \( y \)-intercept.
3) \( g(x) \) and \( j(x) \) have the same end behavior as \( x \to -\infty \).
4) \( g(x) \), \( h(x) \), and \( j(x) \) have rational zeros.

256 The expression \( \frac{4x^3 + 5x + 10}{2x + 3} \) is equivalent to
1) \( 2x^2 + 3x - 7 + \frac{31}{2x + 3} \)
2) \( 2x^2 - 3x + 7 - \frac{11}{2x + 3} \)
3) \( 2x^2 + 2.5x + 5 + \frac{15}{2x + 3} \)
4) \( 2x^2 - 2.5x - 5 - \frac{20}{2x + 3} \)

257 The expression \( \left( \frac{m^2}{\sqrt[3]{m}} \right)^{\frac{1}{2}} \) is equivalent to
1) \( -\sqrt[6]{m^5} \)
2) \( \frac{1}{\sqrt[6]{m^5}} \)
3) \( -\sqrt[6]{m^5} \)
4) \( \frac{1}{\sqrt[6]{m^5}} \)

258 A recursive formula for the sequence \( 18, 9, 4.5, \ldots \) is
1) \( g_1 = 18 \)
\( g_n = \frac{1}{2} g_{n-1} \)
2) \( g_n = 18 \left( \frac{1}{2} \right)^{n-1} \)
3) \( g_1 = 18 \)
\( g_n = 2g_{n-1} \)
4) \( g_n = 18(2)^{n-1} \)
259 The Rickerts decided to set up an account for their daughter to pay for her college education. The day their daughter was born, they deposited $1000 in an account that pays 1.8% compounded annually. Beginning with her first birthday, they deposit an additional $750 into the account on each of her birthdays. Which expression correctly represents the amount of money in the account \( n \) years after their daughter was born?

1) \( a_n = 1000(1.018)^n + 750 \)
2) \( a_n = 1000(1.018)^n + 750n \)
3) \( a_0 = 1000 \)
   \[ a_n = a_{n-1}(1.018) + 750 \]
4) \( a_0 = 1000 \)
   \[ a_n = a_{n-1}(1.018) + 750n \]

260 Algebraically prove that \( \frac{x^3 + 9}{x^3 + 8} = 1 + \frac{1}{x^3 + 8} \), where \( x \neq -2 \).

261 A game spinner is divided into 6 equally sized regions, as shown in the diagram below.

For Miles to win, the spinner must land on the number 6. After spinning the spinner 10 times, and losing all 10 times, Miles complained that the spinner is unfair. At home, his dad ran 100 simulations of spinning the spinner 10 times, assuming the probability of winning each spin is \( \frac{1}{6} \).

The output of the simulation is shown in the diagram below.

262 What is the solution set of the equation \( \frac{3x + 25}{x + 7} - 5 = \frac{3}{x} \)?

1) \( \left\{ \frac{3}{2}, 7 \right\} \)
2) \( \left\{ \frac{7}{2}, -3 \right\} \)
3) \( \left\{ \frac{3}{2}, 7 \right\} \)
4) \( \left\{ \frac{7}{2}, -3 \right\} \)
263 The graph of $p(x)$ is shown below.

What is the remainder when $p(x)$ is divided by $x + 4$?

1) $x - 4$
2) $-4$
3) 0
4) 4

264 A payday loan company makes loans between $100 and $1000 available to customers. Every 14 days, customers are charged 30% interest with compounding. In 2013, Remi took out a $300 payday loan. Which expression can be used to calculate the amount she would owe, in dollars, after one year if she did not make payments?

1) $300(.30)^{\frac{14}{365}}$
2) $300(1.30)^{\frac{14}{365}}$
3) $300(.30)^{\frac{365}{14}}$
4) $300(1.30)^{\frac{365}{14}}$

265 Find algebraically the zeros for $p(x) = x^3 + x^2 - 4x - 4$. On the set of axes below, graph $y = p(x)$.

266 Simon lost his library card and has an overdue library book. When the book was 5 days late, he owed $2.25 to replace his library card and pay the fine for the overdue book. When the book was 21 days late, he owed $6.25 to replace his library card and pay the fine for the overdue book. Suppose the total amount Simon owes when the book is $n$ days late can be determined by an arithmetic sequence. Determine a formula for $a_n$, the $n$th term of this sequence. Use the formula to determine the amount of money, in dollars, Simon needs to pay when the book is 60 days late.
267 Drugs break down in the human body at different rates and therefore must be prescribed by doctors carefully to prevent complications, such as overdosing. The breakdown of a drug is represented by the function \( N(t) = N_0(e^{-rt}) \), where \( N(t) \) is the amount left in the body, \( N_0 \) is the initial dosage, \( r \) is the decay rate, and \( t \) is time in hours.

Patient \( A \), \( A(t) \), is given 800 milligrams of a drug with a decay rate of 0.347. Patient \( B \), \( B(t) \), is given 400 milligrams of another drug with a decay rate of 0.231. Write two functions, \( A(t) \) and \( B(t) \), to represent the breakdown of the respective drug given to each patient. Graph each function on the set of axes below.

To the nearest hour, \( t \), when does the amount of the given drug remaining in patient \( B \) begin to exceed the amount of the given drug remaining in patient \( A \)? The doctor will allow patient \( A \) to take another 800 milligram dose of the drug once only 15% of the original dose is left in the body. Determine, to the nearest tenth of an hour, how long patient \( A \) will have to wait to take another 800 milligram dose of the drug.

268 Describe how a controlled experiment can be created to examine the effect of ingredient \( X \) in a toothpaste.

269 Sean's team has a baseball game tomorrow. He pitches 50% of the games. There is a 40% chance of rain during the game tomorrow. If the probability that it rains given that Sean pitches is 40%, it can be concluded that these two events are
1) independent
2) dependent
3) mutually exclusive
4) complements

270 A study was designed to test the effectiveness of a new drug. Half of the volunteers received the drug. The other half received a sugar pill. The probability of a volunteer receiving the drug and getting well was 40%. What is the probability of a volunteer getting well, given that the volunteer received the drug?

271 Rewrite the expression
\[
\left(4x^2 + 5x\right)^2 - 5\left(4x^2 + 5x\right) - 6
\]
as a product of four linear factors.

272 Given \( f(9) = -2 \), which function can be used to generate the sequence \(-8, -7.25, -6.5, -5.75, \ldots \)?
1) \( f(n) = -8 + 0.75n \)
2) \( f(n) = -8 - 0.75(n - 1) \)
3) \( f(n) = -8.75 + 0.75n \)
4) \( f(n) = -0.75 + 8(n - 1) \)
273 Charlie's Automotive Dealership is considering implementing a new check-in procedure for customers who are bringing their vehicles for routine maintenance. The dealership will launch the procedure if 50% or more of the customers give the new procedure a favorable rating when compared to the current procedure. The dealership devises a simulation based on the minimal requirement that 50% of the customers prefer the new procedure. Each dot on the graph below represents the proportion of the customers who preferred the new check-in procedure, each of sample size 40, simulated 100 times.

![Graph showing proportions](image)

Assume the set of data is approximately normal and the dealership wants to be 95% confident of its results. Determine an interval containing the plausible sample values for which the dealership will launch the new procedure. Round your answer to the nearest hundredth. Forty customers are selected randomly to undergo the new check-in procedure and the proportion of customers who prefer the new procedure is 32.5%. The dealership decides not to implement the new check-in procedure based on the results of the study. Use statistical evidence to explain this decision.

274 While experimenting with her calculator, Candy creates the sequence 4, 9, 19, 39, 79, .... Write a recursive formula for Candy's sequence. Determine the eighth term in Candy's sequence.

275 The volume of air in a person’s lungs, as the person breathes in and out, can be modeled by a sine graph. A scientist is studying the differences in this volume for people at rest compared to people told to take a deep breath. When examining the graphs, should the scientist focus on the amplitude, period, or midline? Explain your choice.

276 The focal length, \( F \), of a camera’s lens is related to the distance of the object from the lens, \( J \), and the distance to the image area in the camera, \( W \), by the formula below.

\[
\frac{1}{J} + \frac{1}{W} = \frac{1}{F}
\]

When this equation is solved for \( J \) in terms of \( F \) and \( W \), \( J \) equals

1) \( F - W \)
2) \( \frac{FW}{F - W} \)
3) \( \frac{FW}{W - F} \)
4) \( \frac{1}{F} - \frac{1}{W} \)
277 Functions \( f, g, \) and \( h \) are given below.

\[
f(x) = \sin(2x) \\
g(x) = f(x) + 1
\]

Which statement is true about functions \( f, g, \) and \( h \)?

1) \( f(x) \) and \( g(x) \) are odd, \( h(x) \) is even.
2) \( f(x) \) and \( g(x) \) are even, \( h(x) \) is odd.
3) \( f(x) \) is odd, \( g(x) \) is neither, \( h(x) \) is even.
4) \( f(x) \) is even, \( g(x) \) is neither, \( h(x) \) is odd.

278 Which equation represents a parabola with the focus at \((0, -1)\) and the directrix of \( y = 1 \)?

1) \( x^2 = -8y \)
2) \( x^2 = -4y \)
3) \( x^2 = 8y \)
4) \( x^2 = 4y \)

279 The function \( f(x) = 2^{-0.25x} \cdot \sin \left( \frac{\pi}{2} x \right) \) represents a damped sound wave function. What is the average rate of change for this function on the interval \([-7, 7]\), to the nearest hundredth?

1) \(-3.66\)
2) \(-0.30\)
3) \(-0.26\)
4) 3.36

280 Which statement is incorrect for the graph of the function \( y = -3 \cos \left( \frac{\pi}{3} (x - 4) \right) + 7 \)?

1) The period is 6.
2) The amplitude is 3.
3) The range is [4,10].
4) The midline is \( y = -4 \).

281 The expression \( \frac{6x^3 + 17x^2 + 10x + 2}{2x + 3} \) equals

1) \( 3x^2 + 4x - 1 + \frac{5}{2x + 3} \)
2) \( 6x^2 + 8x - 2 + \frac{5}{2x + 3} \)
3) \( 6x^2 - x + 13 - \frac{37}{2x + 3} \)
4) \( 3x^2 + 13x + \frac{49}{2} + \frac{151}{2x + 3} \)

282 If \( \sin^2(32^\circ) + \cos^2(M) = 1 \), then \( M \) equals

1) \( 32^\circ \)
2) \( 58^\circ \)
3) \( 68^\circ \)
4) \( 72^\circ \)
283 Stephen’s Beverage Company is considering whether to produce a new brand of cola. The company will launch the product if at least 25% of cola drinkers will buy the product. Fifty cola drinkers are randomly selected to take a blind taste-test of products $A$, $B$, and the new product. Nine out of fifty participants preferred Stephen’s new cola to products $A$ and $B$. The company then devised a simulation based on the requirement that 25% of cola drinkers will buy the product. Each dot in the graph shown below represents the proportion of people who preferred Stephen’s new product, each of sample size 50, simulated 100 times. Assume the set of data is approximately normal and the company wants to be 95% confident of its results. Does the sample proportion obtained from the blind taste-test, nine out of fifty, fall within the margin of error developed from the simulation? Justify your answer. The company decides to continue developing the product even though only nine out of fifty participants preferred its brand of cola in the taste-test. Describe how the simulation data could be used to support this decision.

284 Which statement about statistical analysis is false?
1) Experiments can suggest patterns and relationships in data.
2) Experiments can determine cause and effect relationships.
3) Observational studies can determine cause and effect relationships.
4) Observational studies can suggest patterns and relationships in data.

285 Jasmine decides to put $100 in a savings account each month. The account pays 3% annual interest, compounded monthly. How much money, $S$, will Jasmine have after one year?
1) $S = 100(1.03)^{12}$
2) $S = \frac{100 - 100(1.0025)^{12}}{1 - 1.0025}$
3) $S = 100(1.0025)^{12}$
4) $S = \frac{100 - 100(1.03)^{12}}{1 - 1.03}$

286 Elizabeth waited for 6 minutes at the drive thru at her favorite fast-food restaurant the last time she visited. She was upset about having to wait that long and notified the manager. The manager assured her that her experience was very unusual and that it would not happen again. A study of customers commissioned by this restaurant found an approximately normal distribution of results. The mean wait time was 226 seconds and the standard deviation was 38 seconds. Given these data, and using a 95% level of confidence, was Elizabeth’s wait time unusual? Justify your answer.
287 Over the set of integers, factor the expression
\[4x^3 - x^2 + 16x - 4\] completely.

288 Express \((1 - i)^3\) in \(a + bi\) form.

289 The inverse of the function \(f(x) = \frac{x + 1}{x - 2}\) is

1) \(f^{-1}(x) = \frac{x + 1}{x + 2}\)
2) \(f^{-1}(x) = \frac{2x + 1}{x - 1}\)
3) \(f^{-1}(x) = \frac{x + 1}{x - 2}\)
4) \(f^{-1}(x) = \frac{x - 1}{x + 1}\)

290 Alexa earns $33,000 in her first year of teaching and earns a 4% increase in each successive year. Write a geometric series formula, \(S_n\), for Alexa's total earnings over \(n\) years. Use this formula to find Alexa's total earnings for her first 15 years of teaching, to the nearest cent.

291 The function \(f(x) = \frac{x - 3}{x^2 + 2x - 8}\) is undefined when \(x\) equals

1) 2 or -4
2) 4 or -2
3) 3, only
4) 2, only

292 Factored completely, \(m^5 + m^3 - 6m\) is equivalent to

1) \((m + 3)(m - 2)\)
2) \((m^2 + 3m)(m^2 - 2)\)
3) \(m(m^4 + m^2 - 6)\)
4) \(m(m^2 + 3)(m^2 - 2)\)

293 A manufacturing company has developed a cost model, \(C(x) = 0.15x^3 + 0.01x^2 + 2x + 120\), where \(x\) is the number of items sold, in thousands. The sales price can be modeled by \(S(x) = 30 - 0.01x\). Therefore, revenue is modeled by \(R(x) = x \cdot S(x)\). The company's profit, \(P(x) = R(x) - C(x)\), could be modeled by

1) \(-0.15x^3 + 0.02x^2 - 28x + 120\)
2) \(-0.15x^3 - 0.02x^2 + 28x - 120\)
3) \(-0.15x^3 + 0.01x^2 - 2.01x - 120\)
4) \(-0.15x^3 + 32x + 120\)

294 Which equation is represented by the graph shown below?

1) \(y = \frac{1}{2} \cos 2x\)
2) \(y = \cos x\)
3) \(y = \frac{1}{2} \cos x\)
4) \(y = 2 \cos \frac{1}{2} x\)
295 The graph below represents the height above the ground, \( h \), in inches, of a point on a triathlete's bike wheel during a training ride in terms of time, \( t \), in seconds.

Identify the period of the graph and describe what the period represents in this context.

296 Anne has a coin. She does not know if it is a fair coin. She flipped the coin 100 times and obtained 73 heads and 27 tails. She ran a computer simulation of 200 samples of 100 fair coin flips. The output of the proportion of heads is shown below.

Given the results of her coin flips and of her computer simulation, which statement is most accurate?

1) 73 of the computer's next 100 coin flips will be heads.
2) 50 of her next 100 coin flips will be heads.
3) Her coin is not fair.
4) Her coin is fair.

297 Using the unit circle below, explain why \( \csc \theta = \frac{1}{y} \).

298 Which value, to the nearest tenth, is not a solution of \( p(x) = q(x) \) if \( p(x) = x^3 + 3x^2 - 3x - 1 \) and \( q(x) = 3x + 8\)?

1) \(-3.9\)
2) \(-1.1\)
3) \(2.1\)
4) \(4.7\)
299 Gabriel performed an experiment to see if planting 13 tomato plants in black plastic mulch leads to larger tomatoes than if 13 plants are planted without mulch. He observed that the average weight of the tomatoes from tomato plants grown in black plastic mulch was 5 ounces greater than those from the plants planted without mulch. To determine if the observed difference is statistically significant, he rerandomized the tomato groups 100 times to study these random differences in the mean weights. The output of his simulation is summarized in the dotplot below.

Given these results, what is an appropriate inference that can be drawn?

1) There was no effect observed between the two groups.
2) There was an effect observed that could be due to the random assignment of plants to the groups.
3) There is strong evidence to support the hypothesis that tomatoes from plants planted in black plastic mulch are larger than those planted without mulch.
4) There is strong evidence to support the hypothesis that tomatoes from plants planted without mulch are larger than those planted in black plastic mulch.

300 A circle centered at the origin has a radius of 10 units. The terminal side of an angle, $\theta$, intercepts the circle in Quadrant II at point $C$. The $y$-coordinate of point $C$ is 8. What is the value of $\cos \theta$?

1) $-\frac{3}{5}$
2) $-\frac{3}{4}$
3) $\frac{3}{5}$
4) $\frac{4}{5}$

301 The expression $\frac{x^3 + 2x^2 + x + 6}{x + 2}$ is equivalent to

1) $x^2 + 3$
2) $x^2 + 1 + \frac{4}{x + 2}$
3) $2x^2 + x + 6$
4) $2x^2 + 1 + \frac{4}{x + 2}$

302 Write $(5 + 2yi)(4 - 3i) - (5 - 2yi)(4 - 3i)$ in $a + bi$ form, where $y$ is a real number.
303 Which binomial is a factor of \(x^4 - 4x^2 - 4x + 8\)?

1) \(x - 2\)
2) \(x + 2\)
3) \(x - 4\)
4) \(x + 4\)

304 The formula below can be used to model which scenario?

\[
a_1 = 3000 \\
a_n = 0.80a_{n-1}
\]

1) The first row of a stadium has 3000 seats, and each row thereafter has 80 more seats than the row in front of it.
2) The last row of a stadium has 3000 seats, and each row before it has 80 fewer seats than the row behind it.
3) A bank account starts with a deposit of $3000, and each year it grows by 80%.
4) The initial value of a specialty toy is $3000, and its value each of the following years is 20% less.

305 If the terminal side of angle \(\theta\) in standard position, passes through point \((-4,3)\), what is the numerical value of \(\sin \theta\)?

1) \(\frac{3}{5}\)
2) \(\frac{4}{5}\)
3) \(-\frac{3}{5}\)
4) \(-\frac{4}{5}\)

306 Jim is looking to buy a vacation home for $172,600 near his favorite southern beach. The formula to compute a mortgage payment, \(M\), is

\[
M = P \cdot \frac{r(1 + r)^N}{(1 + r)^N - 1}
\]

where \(P\) is the principal amount of the loan, \(r\) is the monthly interest rate, and \(N\) is the number of monthly payments. Jim's bank offers a monthly interest rate of 0.305% for a 15-year mortgage. With no down payment, determine Jim's mortgage payment, rounded to the nearest dollar. Algebraically determine and state the down payment, rounded to the nearest dollar, that Jim needs to make in order for his mortgage payment to be $1100.

307 Pedro and Bobby each own an ant farm. Pedro starts with 100 ants and says his farm is growing exponentially at a rate of 15% per month. Bobby starts with 350 ants and says his farm is steadily decreasing by 5 ants per month. Assuming both boys are accurate in describing the population of their ant farms, after how many months will they both have approximately the same number of ants?

1) 7
2) 8
3) 13
4) 36

308 What is the completely factored form of \(k^4 - 4k^3 + 8k^3 - 32k + 12k^2 - 48\)?

1) \((k - 2)(k - 2)(k + 3)(k + 4)\)
2) \((k - 2)(k + 6)(k + 2)\)
3) \((k + 2)(k - 2)(k + 3)(k + 4)\)
4) \((k + 2)(k - 2)(k + 6)(k + 2)\)
A study conducted in 2004 in New York City found that 212 out of 1334 participants had hypertension. Kim ran a simulation of 100 studies based on these data. The output of the simulation is shown in the diagram below.

At a 95% confidence level, the proportion of New York City residents with hypertension and the margin of error are closest to
1) proportion ≈ .16; margin of error ≈ .01
2) proportion ≈ .16; margin of error ≈ .02
3) proportion ≈ .01; margin of error ≈ .16
4) proportion ≈ .02; margin of error ≈ .16

The Ferris wheel at the landmark Navy Pier in Chicago takes 7 minutes to make one full rotation. The height, \( H \), in feet, above the ground of one of the six-person cars can be modeled by
\[
H(t) = 70 \sin \left( \frac{2\pi}{7} (t - 1.75) \right) + 80,
\]
where \( t \) is time, in minutes. Using \( H(t) \) for one full rotation, this car's minimum height, in feet, is
1) 150
2) 70
3) 10
4) 0

Graph \( y = \log_2(x + 3) - 5 \) on the set of axes below. Use an appropriate scale to include both intercepts. Describe the behavior of the given function as \( x \) approaches -3 and as \( x \) approaches positive infinity.

On the axes below, sketch a possible function \( p(x) = (x - a)(x - b)(x + c) \), where \( a, b, \) and \( c \) are positive, \( a > b \), and \( p(x) \) has a positive \( y \)-intercept of \( d \). Label all intercepts.
313 Graph the following function on the axes below.  
\[ f(x) = \log_3(2 - x) \]

State the domain of \( f \). State the equation of the asymptote.

314 The roots of the equation \( x^2 + 2x + 5 = 0 \) are
1) -3 and 1
2) -1, only
3) \( -1 + 2i \) and \( -1 - 2i \)
4) \( -1 + 4i \) and \( -1 - 4i \)

315 The speed of a tidal wave, \( s \), in hundreds of miles per hour, can be modeled by the equation \( s = \sqrt{t - 2t + 6} \), where \( t \) represents the time from its origin in hours. Algebraically determine the time when \( s = 0 \). How much faster was the tidal wave traveling after 1 hour than 3 hours, to the nearest mile per hour? Justify your answer.

316 A public opinion poll was conducted on behalf of Mayor Ortega's reelection campaign shortly before the election. 264 out of 550 likely voters said they would vote for Mayor Ortega; the rest said they would vote for his opponent. Which statement is least appropriate to make, according to the results of the poll?
1) There is a 48% chance that Mayor Ortega will win the election.
2) The point estimate (\( \hat{p} \)) of voters who will vote for Mayor Ortega is 48%.
3) It is most likely that between 44% and 52% of voters will vote for Mayor Ortega.
4) Due to the margin of error, an inference cannot be made regarding whether Mayor Ortega or his opponent is most likely to win the election.

317 Last year, the total revenue for Home Style, a national restaurant chain, increased 5.25% over the previous year. If this trend were to continue, which expression could the company's chief financial officer use to approximate their monthly percent increase in revenue? [Let \( m \) represent months.]
1) \( (1.0525)^m \)
2) \( \frac{12}{m} \)
3) \( (1.00427)^m \)
4) \( \left( \frac{1}{1.00427} \right)^{\frac{m}{12}} \)

318 The zeros for \( f(x) = x^4 - 4x^3 - 9x^2 + 36x \) are
1) \( \{0, \pm 3, 4\} \)
2) \( \{0, 3, 4\} \)
3) \( \{0, \pm 3, -4\} \)
4) \( \{0, 3, -4\} \)
319 The function \( M(t) \) represents the mass of radium over time, \( t \), in years.

\[
M(t) = 100e^{\frac{\ln \frac{1}{2}}{1590} t}
\]

Determine if the function \( M(t) \) represents growth or decay. Explain your reasoning.

320 Which equation has \( 1 - i \) as a solution?
1) \( x^2 + 2x - 2 = 0 \)
2) \( x^2 + 2x + 2 = 0 \)
3) \( x^2 - 2x - 2 = 0 \)
4) \( x^2 - 2x + 2 = 0 \)

321 Verify the following Pythagorean identity for all values of \( x \) and \( y \):

\[
(x^2 + y^2)^2 = (x^2 - y^2)^2 + (2xy)^2
\]

322 Solve algebraically for all values of \( x \):

\[
\sqrt{x - 4} + x = 6
\]

323 The equation \( 4x^2 - 24x + 4y^2 + 72y = 76 \) is equivalent to
1) \( 4(x - 3)^2 + 4(y + 9)^2 = 76 \)
2) \( 4(x - 3)^2 + 4(y + 9)^2 = 121 \)
3) \( 4(x - 3)^2 + 4(y + 9)^2 = 166 \)
4) \( 4(x - 3)^2 + 4(y + 9)^2 = 436 \)

324 The guidance department has reported that of the senior class, 2.3% are members of key club, \( K \), 8.6% are enrolled in AP Physics, \( P \), and 1.9% are in both. Determine the probability of \( P \) given \( K \), to the nearest tenth of a percent. The principal would like a basic interpretation of these results. Write a statement relating your calculated probabilities to student enrollment in the given situation.

325 A cardboard box manufacturing company is building boxes with length represented by \( x + 1 \), width by \( 5 - x \), and height by \( x - 1 \). The volume of the box is modeled by the function below.

Over which interval is the volume of the box changing at the fastest average rate?
1) \([1, 2]\)
2) \([1, 3.5]\)
3) \([1, 5]\)
4) \([0, 3.5]\)

326 Given \( r(x) = x^3 - 4x^2 + 4x - 6 \), find the value of \( r(2) \). What does your answer tell you about \( x - 2 \) as a factor of \( r(x) \)? Explain.
327 Which equation represents an odd function?
1) \( y = \sin x \)
2) \( y = \cos x \)
3) \( y = (x + 1)^3 \)
4) \( y = e^{5x} \)

328 When \( b > 0 \) and \( d \) is a positive integer, the expression \((3b)^\frac{2}{d}\) is equivalent to
1) \( \frac{1}{(\sqrt[2]{3b})^2} \)
2) \( (\sqrt[2]{3b})^d \)
3) \( \frac{1}{\sqrt[2]{3b^d}} \)
4) \( (\sqrt[2]{3b})^{\frac{2}{d}} \)

329 Explain how \( \left( \frac{1}{3} \right)^2 \) can be written as the equivalent radical expression \( \sqrt[5]{9} \).

330 The function \( p(t) = 110e^{0.03922t} \) models the population of a city, in millions, \( t \) years after 2010. As of today, consider the following two statements:
I. The current population is 110 million.
II. The population increases continuously by approximately 3.9\% per year.
This model supports
1) I, only
2) II, only
3) both I and II
4) neither I nor II

331 Solve the following system of equations algebraically for all values of \( x, y, \) and \( z \):
\[
\begin{align*}
x + y + z &= 1 \\
2x + 4y + 6z &= 2 \\
-x + 3y - 5z &= 11
\end{align*}
\]

332 The population of Jamesburg for the years 2010-2013, respectively, was reported as follows: 250,000 250,937 251,878 252,822
How can this sequence be recursively modeled?
1) \( j_n = 250,000(1.00375)^{n-1} \)
2) \( j_n = 250,000 + 937(n-1) \)
3) \( j_1 = 250,000 \)
4) \( j_n = j_{n-1} + 937 \)

333 Algebraically prove that the difference of the squares of any two consecutive integers is an odd integer.

334 Algebraically determine the values of \( x \) that satisfy the system of equations below:
\[
\begin{align*}
y &= -2x + 1 \\
y &= -2x^2 + 3x + 1
\end{align*}
\]

335 Given events \( A \) and \( B \), such that \( P(A) = 0.6 \), \( P(B) = 0.5 \), and \( P(A \cup B) = 0.8 \), determine whether \( A \) and \( B \) are independent or dependent.
The solution set for the equation $\sqrt{56-x} = x$ is
1) $\{-8, 7\}$
2) $\{-7, 8\}$
3) $\{7\}$
4) $\{\}$

According to a pricing website, Indroid phones lose 58% of their cash value over 1.5 years. Which expression can be used to estimate the value of a $300 Indroid phone in 1.5 years?
1) $300e^{-0.87}$
2) $300e^{-0.63}$
3) $300e^{-0.58}$
4) $300e^{-0.42}$

The graph of the function $p(x)$ is sketched below.

Which equation could represent $p(x)$?
1) $p(x) = (x^2 - 9)(x - 2)$
2) $p(x) = x^3 - 2x^2 + 9x + 18$
3) $p(x) = (x^2 + 9)(x - 2)$
4) $p(x) = x^3 + 2x^2 - 9x - 18$

The directrix of the parabola $12(y + 3) = (x - 4)^2$ has the equation $y = -6$. Find the coordinates of the focus of the parabola.

The solution to the equation $18x^2 - 24x + 87 = 0$ is
1) $\frac{2}{3} \pm 6i\sqrt{158}$
2) $\frac{2}{3} \pm \frac{1}{6}i\sqrt{158}$
3) $\frac{2}{3} \pm 6i\sqrt{158}$
4) $\frac{2}{3} \pm \frac{1}{6}i\sqrt{158}$

After sitting out of the refrigerator for a while, a turkey at room temperature (68°F) is placed into an oven at 8 a.m., when the oven temperature is 325°F. Newton’s Law of Heating explains that the temperature of the turkey will increase proportionally to the difference between the temperature of the turkey and the temperature of the oven, as given by the formula below:

$$T = T_a + (T_0 - T_a)e^{-kt}$$

$T_a$ = the temperature surrounding the object

$T_0$ = the initial temperature of the object

$t$ = the time in hours

$T$ = the temperature of the object after $t$ hours

$k$ = decay constant

The turkey reaches the temperature of approximately 100° F after 2 hours. Find the value of $k$, to the nearest thousandth, and write an equation to determine the temperature of the turkey after $t$ hours. Determine the Fahrenheit temperature of the turkey, to the nearest degree, at 3 p.m.
342 When \( g(x) \) is divided by \( x + 4 \), the remainder is 0. Given \( g(x) = x^4 + 3x^3 - 6x^2 - 6x + 8 \), which conclusion about \( g(x) \) is true?
1) \( g(4) = 0 \)
2) \( g(-4) = 0 \)
3) \( x - 4 \) is a factor of \( g(x) \).
4) No conclusion can be made regarding \( g(x) \).

343 Kristin wants to increase her running endurance. According to experts, a gradual mileage increase of 10% per week can reduce the risk of injury. If Kristin runs 8 miles in week one, which expression can help her find the total number of miles she will have run over the course of her 6-week training program?
1) \( 8(1.10)^n - 1 \)
2) \( 8(1.10)^n \)
3) \( 8 - 8(1.10)^6 - 0.90 \)
4) \( 8 - 8(0.10)^n \)

344 An equation to represent the value of a car after \( t \) months of ownership is \( v = 32,000(0.81)^{\frac{t}{12}} \). Which statement is not correct?
1) The car lost approximately 19% of its value each month.
2) The car maintained approximately 98% of its value each month.
3) The value of the car when it was purchased was $32,000.
4) The value of the car 1 year after it was purchased was $25,920.

345 Which factorization is incorrect?
1) \( 4k^2 - 49 = (2k + 7)(2k - 7) \)
2) \( a^3 - 8b^3 = (a - 2b)(a^2 + 2ab + 4b^2) \)
3) \( m^3 + 3m^2 - 4m + 12 = (m - 2)(m + 3) \)
4) \( t^3 + 5t^2 + 6t + t^2 + 5t + 6 = (t + 1)(t + 2)(t + 3) \)

346 Biologists are studying a new bacterium. They create a culture with 100 of the bacteria and anticipate that the number of bacteria will double every 30 hours. Write an equation for the number of bacteria, \( B \), in terms of the number of hours, \( t \), since the experiment began.

347 If \( g(c) = 1 - c^2 \) and \( m(c) = c + 1 \), then which statement is not true?
1) \( g(c) \cdot m(c) = 1 + c - c^2 - c^3 \)
2) \( g(c) + m(c) = 2 + c - c^2 \)
3) \( m(c) - g(c) = c + c^2 \)
4) \( \frac{m(c)}{g(c)} = \frac{-1}{1 - c} \)

348 Using the identity \( \sin^2 \theta + \cos^2 \theta = 1 \), find the value of \( \tan \theta \), to the nearest hundredth, if \( \cos \theta = -0.7 \) and \( \theta \) is in Quadrant II.

349 Simplify \( xi(i - 7i)^2 \), where \( i \) is the imaginary unit.
350 The \( x \)-value of which function’s \( x \)-intercept is larger, \( f \) or \( h \)? Justify your answer.

\[
f(x) = \log(x - 4)
\]

<table>
<thead>
<tr>
<th>( x )</th>
<th>( h(x) )</th>
</tr>
</thead>
<tbody>
<tr>
<td>-1</td>
<td>6</td>
</tr>
<tr>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>3</td>
<td>-2</td>
</tr>
</tbody>
</table>

351 Which function shown below has a greater average rate of change on the interval \([-2,4]\)? Justify your answer.

\[
g(x) = 4x^3 - 5x^2 + 3
\]

352 The results of a survey of the student body at Central High School about television viewing preferences are shown below.

<table>
<thead>
<tr>
<th></th>
<th>Comedy Series</th>
<th>Drama Series</th>
<th>Reality Series</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Males</td>
<td>95</td>
<td>65</td>
<td>70</td>
<td>230</td>
</tr>
<tr>
<td>Females</td>
<td>80</td>
<td>70</td>
<td>110</td>
<td>260</td>
</tr>
<tr>
<td>Total</td>
<td>175</td>
<td>135</td>
<td>180</td>
<td>490</td>
</tr>
</tbody>
</table>

Are the events “student is a male” and “student prefers reality series” independent of each other? Justify your answer.
The distance needed to stop a car after applying the brakes varies directly with the square of the car’s speed. The table below shows stopping distances for various speeds.

<table>
<thead>
<tr>
<th>Speed (mph)</th>
<th>10</th>
<th>20</th>
<th>30</th>
<th>40</th>
<th>50</th>
<th>60</th>
<th>70</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distance (ft)</td>
<td>6.25</td>
<td>25</td>
<td>56.25</td>
<td>100</td>
<td>156.25</td>
<td>225</td>
<td>306.25</td>
</tr>
</tbody>
</table>

Determine the average rate of change in braking distance, in ft/mph, between one car traveling at 50 mph and one traveling at 70 mph. Explain what this rate of change means as it relates to braking distance.

To solve \( \frac{2x}{x-2} - 11 \frac{x}{x^2 - 2x} = \frac{8}{x^2 - 2x} \), Ren multiplied both sides by the least common denominator. Which statement is true?
1) 2 is an extraneous solution.
2) \( \frac{7}{2} \) is an extraneous solution.
3) 0 and 2 are extraneous solutions.
4) This equation does not contain any extraneous solutions.

Solve the system of equations shown below algebraically.
\[(x - 3)^2 + (y + 2)^2 = 16\]
\[2x + 2y = 10\]

If \( p(x) = ab^x \) and \( r(x) = cd^x \), then \( p(x) \cdot r(x) \) equals
1) \( ac(b + d)^x \)
2) \( ac(b + d)^{2x} \)
3) \( ac(bd)^x \)
4) \( ac(bd)^{2x} \)

A house purchased 5 years ago for $100,000 was just sold for $135,000. Assuming exponential growth, approximate the annual growth rate, to the nearest percent.

When \( g(x) = \frac{2}{x + 2} \) and \( h(x) = \log(x + 1) + 3 \) are graphed on the same set of axes, which coordinates best approximate their point of intersection?
1) \((-0.9, 1.8)\)
2) \((-0.9, 1.9)\)
3) \((1.4, 3.3)\)
4) \((1.4, 3.4)\)

A parabola has its focus at (1,2) and its directrix is \( y = -2 \). The equation of this parabola could be
1) \( y = 8(x + 1)^2 \)
2) \( y = \frac{1}{8} (x + 1)^2 \)
3) \( y = 8(x - 1)^2 \)
4) \( y = \frac{1}{8} (x - 1)^2 \)
Titanium-44 is a radioactive isotope such that every 63 years, its mass decreases by half. For a sample of titanium-44 with an initial mass of 100 grams, write a function that will give the mass of the sample remaining after any amount of time. Define all variables. Scientists sometimes use the average yearly decrease in mass for estimation purposes. Use the average yearly decrease in mass of the sample between year 0 and year 10 to predict the amount of the sample remaining after 40 years. Round your answer to the nearest tenth. Is the actual mass of the sample or the estimated mass greater after 40 years? Justify your answer.

Write an explicit formula for $a_n$, the $n$th term of the recursively defined sequence below.

\[
a_1 = x + 1 \\
a_n = x(a_{n-1})
\]

For what values of $x$ would $a_n = 0$ when $n > 1$?

For $n$ and $p > 0$, is the expression

\[
\left( p^2 \cdot n^2 \right)^{\frac{1}{8}} \sqrt[5]{p^4 \cdot n^4} \quad \text{equivalent to} \quad p^{18} \cdot n^6 \cdot \sqrt[n^4]{p^x}?
\]

Justify your answer.

If $f(x) = 3|x| - 1$ and $g(x) = 0.03x^3 - x + 1$, an approximate solution for the equation $f(x) = g(x)$ is

1) 1.96  
2) 11.29  
3) (-0.99, 1.96)  
4) (11.29, 32.87)

State when $V(t) = Z(t)$, to the nearest hundredth, and interpret its meaning in the context of the problem. Zach takes out an insurance policy that requires him to pay a $3000 deductible in case of a collision. Zach will cancel the collision policy when the value of his car equals his deductible. To the nearest year, how long will it take Zach to cancel this policy? Justify your answer.
366 In 2013, approximately 1.6 million students took the Critical Reading portion of the SAT exam. The mean score, the modal score, and the standard deviation were calculated to be 496, 430, and 115, respectively. Which interval reflects 95% of the Critical Reading scores?
1) $430 \pm 115$
2) $430 \pm 230$
3) $496 \pm 115$
4) $496 \pm 230$

367 Seth’s parents gave him $5000 to invest for his 16th birthday. He is considering two investment options. Option A will pay him 4.5% interest compounded annually. Option B will pay him 4.6% compounded quarterly. Write a function of option A and option B that calculates the value of each account after $n$ years. Seth plans to use the money after he graduates from college in 6 years. Determine how much more money option B will earn than option A to the nearest cent. Algebraically determine, to the nearest tenth of a year, how long it would take for option B to double Seth’s initial investment.

368 Which value is not contained in the solution of the system shown below?
\[
\begin{align*}
a + 5b - c &= -20 \\
4a - 5b + 4c &= 19 \\
-a - 5b - 5c &= 2
\end{align*}
\]
1) $-2$
2) $2$
3) $3$
4) $-3$

369 Solve for $x$: \[\frac{1}{x} - \frac{1}{3} = \frac{-1}{3x}\]
Ayva designed an experiment to determine the effect of a new energy drink on a group of 20 volunteer students. Ten students were randomly selected to form group 1 while the remaining 10 made up group 2. Each student in group 1 drank one energy drink, and each student in group 2 drank one cola drink. Ten minutes later, their times were recorded for reading the same paragraph of a novel. The results of the experiment are shown below.

<table>
<thead>
<tr>
<th>Group 1 (seconds)</th>
<th>Group 2 (seconds)</th>
</tr>
</thead>
<tbody>
<tr>
<td>17.4</td>
<td>23.3</td>
</tr>
<tr>
<td>18.1</td>
<td>18.8</td>
</tr>
<tr>
<td>18.2</td>
<td>22.1</td>
</tr>
<tr>
<td>19.6</td>
<td>12.7</td>
</tr>
<tr>
<td>18.6</td>
<td>16.9</td>
</tr>
<tr>
<td>16.2</td>
<td>24.4</td>
</tr>
<tr>
<td>16.1</td>
<td>21.2</td>
</tr>
<tr>
<td>15.3</td>
<td>21.2</td>
</tr>
<tr>
<td>17.8</td>
<td>16.3</td>
</tr>
<tr>
<td>19.7</td>
<td>14.5</td>
</tr>
</tbody>
</table>

Mean = 17.7
Mean = 19.1

Ayva thinks drinking energy drinks makes students read faster. Using information from the experimental design or the results, explain why Ayva’s hypothesis may be incorrect. Using the given results, Ayva randomly mixes the 20 reading times, splits them into two groups of 10, and simulates the difference of the means 232 times.

Ayva has decided that the difference in mean reading times is not an unusual occurrence. Support her decision using the results of the simulation. Explain your reasoning.
373 Data collected about jogging from students with two older siblings are shown in the table below.

<table>
<thead>
<tr>
<th></th>
<th>Neither Sibling Jog</th>
<th>One Sibling Jog</th>
<th>Both Siblings Jog</th>
</tr>
</thead>
<tbody>
<tr>
<td>Student Does Not Jog</td>
<td>1168</td>
<td>1823</td>
<td>1380</td>
</tr>
<tr>
<td>Student Jog</td>
<td>188</td>
<td>416</td>
<td>400</td>
</tr>
</tbody>
</table>

Using these data, determine whether a student with two older siblings is more likely to jog if one sibling jogs or if both siblings jog. Justify your answer.

374 The heights of women in the United States are normally distributed with a mean of 64 inches and a standard deviation of 2.75 inches. The percent of women whose heights are between 64 and 69.5 inches, to the nearest whole percent, is

1) 6
2) 48
3) 68
4) 95

375 The voltage used by most households can be modeled by a sine function. The maximum voltage is 120 volts, and there are 60 cycles every second. Which equation best represents the value of the voltage as it flows through the electric wires, where \( t \) is time in seconds?

1) \( V = 120 \sin(60t) \)
2) \( V = 120 \sin(60t) \)
3) \( V = 120 \sin(60\pi t) \)
4) \( V = 120 \sin(120\pi t) \)

376 In New York State, the minimum wage has grown exponentially. In 1966, the minimum wage was $1.25 an hour and in 2015, it was $8.75. Algebraically determine the rate of growth to the nearest percent.

377 There was a study done on oxygen consumption of snails as a function of pH, and the result was a degree 4 polynomial function whose graph is shown below.

Which statement about this function is incorrect?

1) The degree of the polynomial is even.
2) There is a positive leading coefficient.
3) At two pH values, there is a relative maximum value.
4) There are two intervals where the function is decreasing.
378 Graph $y = 400(0.85)^{2x} - 6$ on the set of axes below.

379 Determine if $x - 5$ is a factor of $2x^3 - 4x^2 - 7x - 10$. Explain your answer.

380 Which statement about the graph of $c(x) = \log_6 x$ is false?
1) The asymptote has equation $y = 0$.
2) The graph has no y-intercept.
3) The domain is the set of positive reals.
4) The range is the set of all real numbers.

381 One of the medical uses of Iodine–131 (I–131), a radioactive isotope of iodine, is to enhance x-ray images. The half-life of I–131 is approximately 8.02 days. A patient is injected with 20 milligrams of I–131. Determine, to the nearest day, the amount of time needed before the amount of I–131 in the patient’s body is approximately 7 milligrams.

382 Given $f^{-1}(x) = -\frac{3}{4}x + 2$, which equation represents $f(x)$?
1) $f(x) = \frac{4}{3}x - \frac{8}{3}$
2) $f(x) = -\frac{4}{3}x + \frac{8}{3}$
3) $f(x) = \frac{3}{4}x - 2$
4) $f(x) = -\frac{3}{4}x + 2$

383 Use an appropriate procedure to show that $x - 4$ is a factor of the function $f(x) = 2x^3 - 5x^2 - 11x - 4$. Explain your answer.

384 A polynomial equation of degree three, $p(x)$, is used to model the volume of a rectangular box. The graph of $p(x)$ has x intercepts at $-2$, $10$, and $14$. Which statements regarding $p(x)$ could be true?
A. The equation of $p(x) = (x - 2)(x + 10)(x + 14)$.
B. The equation of $p(x) = -(x + 2)(x - 10)(x - 14)$.
C. The maximum volume occurs when $x = 10$.
D. The maximum volume of the box is approximately 56.
1) $A$ and $C$
2) $A$ and $D$
3) $B$ and $C$
4) $B$ and $D$

385 Given $z(x) = 6x^3 + bx^2 - 52x + 15$, $z(2) = 35$, and $z(-5) = 0$, algebraically determine all the zeros of $z(x)$. 

386 Graph $y = 400(0.85)^{2x} - 6$ on the set of axes below.
The results of a poll of 200 students are shown in the table below:

<table>
<thead>
<tr>
<th>Preferred Music Style</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Techno</td>
<td>Rap</td>
</tr>
<tr>
<td>Female</td>
<td>54</td>
<td>25</td>
</tr>
<tr>
<td>Male</td>
<td>36</td>
<td>40</td>
</tr>
</tbody>
</table>

For this group of students, do these data suggest that gender and preferred music styles are independent of each other? Justify your answer.

Monthly mortgage payments can be found using the formula below:

\[
M = \frac{P \left( \frac{r}{12} \right) \left( 1 + \frac{r}{12} \right)^n}{1 + \frac{r}{12} - 1}
\]

\[M = \text{monthly payment}\]
\[P = \text{amount borrowed}\]
\[r = \text{annual interest rate}\]
\[n = \text{number of monthly payments}\]

The Banks family would like to borrow $120,000 to purchase a home. They qualified for an annual interest rate of 4.8%. Algebraically determine the fewest number of whole years the Banks family would need to include in the mortgage agreement in order to have a monthly payment of no more than $720.

To the nearest tenth, the value of \(x\) that satisfies \(2^x = -2x + 11\) is

1) 2.5
2) 2.6
3) 5.8
4) 5.9

Relative to the graph of \(y = 3 \sin x\), what is the shift of the graph of \(y = 3 \sin \left( x + \frac{\pi}{3} \right)\)?

1) \(\frac{\pi}{3}\) right
2) \(\frac{\pi}{3}\) left
3) \(\frac{\pi}{3}\) up
4) \(\frac{\pi}{3}\) down

Consider the system shown below.

\[
2x - y = 4
\]
\[
(x + 3)^2 + y^2 = 8
\]

The two solutions of the system can be described as

1) both imaginary
2) both irrational
3) both rational
4) one rational and one irrational

Write \(\sqrt[3]{x} \cdot \sqrt[3]{x}\) as a single term with a rational exponent.
392 A study of the annual population of the red-winged blackbird in Ft. Mill, South Carolina, shows the population, \(B(t)\), can be represented by the function 
\[
B(t) = 750(1.16)^t
\]
where the \(t\) represents the number of years since the study began. In terms of the monthly rate of growth, the population of red-winged blackbirds can be best approximated by the function
1) \(B(t) = 750(1.012)^t\)
2) \(B(t) = 750(1.012)^{12t}\)
3) \(B(t) = 750(1.16)^{12t}\)
4) \(B(t) = 750(1.16)^{\frac{t}{12}}\)

393 Which binomial is not a factor of the expression \(x^3 - 11x^2 + 16x + 84\)?
1) \(x + 2\)
2) \(x + 4\)
3) \(x - 6\)
4) \(x - 7\)

394 What does \(\left(\frac{-54x^9}{y^6}\right)^{\frac{2}{3}}\) equal?
1) \(\frac{9x^{6\sqrt[3]{4}}}{y^{2\sqrt[3]{4}}}\)
2) \(\frac{9x^{6\sqrt[3]{4}}}{y^{2\sqrt[3]{4}}}\)
3) \(\frac{9x^{6\sqrt[3]{4}}}{y^{3\sqrt{y}}}\)
4) \(\frac{9x^{6\sqrt[3]{4}}}{y^{2\sqrt{y}}}\)

395 Mrs. Jones had hundreds of jelly beans in a bag that contained equal numbers of six different flavors. Her student randomly selected four jelly beans and they were all black licorice. Her student complained and said "What are the odds I got all of that kind?" Mrs. Jones replied, "simulate rolling a die 250 times and tell me if four black licorice jelly beans is unusual." Explain how this simulation could be used to solve the problem.

396 Based on climate data that have been collected in Bar Harbor, Maine, the average monthly temperature, in degrees F, can be modeled by the equation 
\[
B(x) = 23.914 \sin(0.508x - 2.116) + 55.300.
\]
The same governmental agency collected average monthly temperature data for Phoenix, Arizona, and found the temperatures could be modeled by the equation 
\[
P(x) = 20.238 \sin(0.525x - 2.148) + 86.729.
\]
Which statement cannot be concluded based on the average monthly temperature models \(x\) months after starting data collection?
1) The average monthly temperature variation is more in Bar Harbor than in Phoenix.
2) The midline average monthly temperature for Bar Harbor is lower than the midline temperature for Phoenix.
3) The maximum average monthly temperature for Bar Harbor is 79° F, to the nearest degree.
4) The minimum average monthly temperature for Phoenix is 20° F, to the nearest degree.

397 Given the equal terms \(\sqrt[3]{x^5}\) and \(\sqrt[6]{y^5}\), determine and state \(y\), in terms of \(x\).
398 A radioactive substance has a mass of 140 g at 3 p.m. and 100 g at 8 p.m. Write an equation in the form \( A = A_0 \left( \frac{1}{2} \right)^{\frac{t}{h}} \) that models this situation, where \( h \) is the constant representing the number of hours in the half-life, \( A_0 \) is the initial mass, and \( A \) is the mass \( t \) hours after 3 p.m. Using this equation, solve for \( h \), to the nearest ten thousandth. Determine when the mass of the radioactive substance will be 40 g. Round your answer to the nearest tenth of an hour.

399 What is the solution to the system of equations \( y = 3x - 2 \) and \( y = g(x) \) where \( g(x) \) is defined by the function below?

\[
y = 3x - 2 \quad \text{and} \quad y = x^2 + 3x - 20
\]

400 The solution set for the equation \( \sqrt{x+14} - \sqrt{2x+5} = 1 \) is

1) \{6\}  
2) \{-6\}  
3) \{2\}  
4) \{18\}

401 What is the solution to \( 8(2^{x+3}) = 48 \)?

1) \( x = \frac{\ln 6}{\ln 2} - 3 \)  
2) \( x = 0 \)  
3) \( x = \frac{\ln 48}{\ln 16} - 3 \)  
4) \( x = \ln 4 - 3 \)

402 For \( x \neq 0 \), which expressions are equivalent to one divided by the sixth root of \( x^6 \)?

I. \( \frac{6\sqrt{x}}{\sqrt[6]{x}} \)  
II. \( \frac{1}{x^6} \)  
III. \( \frac{-1}{x} \)

1) I and II, only  
2) I and III, only  
3) II and III, only  
4) I, II, and III

403 Given \( f(x) = 3x^2 + 7x - 20 \) and \( g(x) = x - 2 \), state the quotient and remainder of \( \frac{f(x)}{g(x)} \), in the form \( q(x) + \frac{r(x)}{g(x)} \).
404 A sine function increasing through the origin can be used to model light waves. Violet light has a wavelength of 400 nanometers. Over which interval is the height of the wave decreasing, only?
1) (0,200)
2) (100,300)
3) (200,400)
4) (300,400)

405 Which expression has been rewritten correctly to form a true statement?
1) \((x + 2)^2 + 2(x + 2) - 8 = (x + 6)x\)
2) \(x^4 + 4x^2 + 9x^2y^2 - 36y^2 = (x + 3y)^2(x - 2)^2\)
3) \(x^3 + 3x^2 - 4xy^2 - 12y^2 = (x - 2y)(x+3)^2\)
4) \((x^2 - 4)^2 - 5(x^2 - 4) - 6 = (x^2 - 7)(x^2 - 6)\)

406 Graph \(y = x^3 - 4x^2 + 2x + 7\) on the set of axes below.

407 Algebraically determine whether the function \(f(x) = x^4 - 3x^2 - 4\) is odd, even, or neither.

408 Which sinusoid has the greatest amplitude?
1) \(y = 3\sin(\theta - 3) + 5\)
2) \(y = 5\sin(\theta - 1) - 3\)
3) \(y = -5\sin(\theta - 1) - 3\)

409 Given that \(\sin^2 \theta + \cos^2 \theta = 1\) and \(\sin \theta = -\frac{\sqrt{2}}{5}\), what is a possible value of \(\cos \theta\)?
1) \(\frac{5 + \sqrt{2}}{5}\)
2) \(\frac{\sqrt{23}}{5}\)
3) \(\frac{3\sqrt{3}}{5}\)
4) \(\frac{\sqrt{35}}{5}\)
410 Visible light can be represented by sinusoidal waves. Three visible light waves are shown in the graph below. The midline of each wave is labeled \( f \).

Based on the graph, which light wave has the longest period? Justify your answer.

411 Iridium-192 is an isotope of iridium and has a half-life of 73.83 days. If a laboratory experiment begins with 100 grams of Iridium-192, the number of grams, \( A \), of Iridium-192 present after \( t \) days would be \( A = 100 \left( \frac{1}{2} \right)^{\frac{t}{73.83}} \). Which equation approximates the amount of Iridium-192 present after \( t \) days?

1) \( A = 100 \left( \frac{73.83}{2} \right)^t \)
2) \( A = 100 \left( \frac{1}{147.66} \right)^t \)
3) \( A = 100(0.990656)^t \)
4) \( A = 100(0.116381)^t \)

412 For the function \( f(x) = (x - 3)^3 + 1 \), find \( f^{-1}(x) \).

413 What are the zeros of \( P(m) = (m^2 - 4)(m^2 + 1) \)?

1) 2 and -2, only
2) 2, -2, and -4
3) -4, \( i \), and \(-i\)
4) 2, -2, \( i \), and \(-i\)

414 Given \( i \) is the imaginary unit, \((2 - yi)^2 \) in simplest form is

1) \( y^2 - 4yi + 4 \)
2) \(-y^2 - 4yi + 4 \)
3) \(-y^2 + 4 \)
4) \( y^2 + 4 \)
415 Using a microscope, a researcher observed and recorded the number of bacteria spores on a large sample of uniformly sized pieces of meat kept at room temperature. A summary of the data she recorded is shown in the table below.

<table>
<thead>
<tr>
<th>Hours (x)</th>
<th>Average Number of Spores (y)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>0.5</td>
<td>10</td>
</tr>
<tr>
<td>1</td>
<td>15</td>
</tr>
<tr>
<td>2</td>
<td>60</td>
</tr>
<tr>
<td>3</td>
<td>260</td>
</tr>
<tr>
<td>4</td>
<td>1130</td>
</tr>
<tr>
<td>6</td>
<td>16,380</td>
</tr>
</tbody>
</table>

Using these data, write an exponential regression equation, rounding all values to the nearest thousandth. The researcher knows that people are likely to suffer from food-borne illness if the number of spores exceeds 100. Using the exponential regression equation, determine the maximum amount of time, to the nearest quarter hour, that the meat can be kept at room temperature safely.

416 Which statement(s) about statistical studies is true?
I. A survey of all English classes in a high school would be a good sample to determine the number of hours students throughout the school spend studying.
II. A survey of all ninth graders in a high school would be a good sample to determine the number of student parking spaces needed at that high school.
III. A survey of all students in one lunch period in a high school would be a good sample to determine the number of hours adults spend on social media websites.
IV. A survey of all Calculus students in a high school would be a good sample to determine the number of students throughout the school who don’t like math.

1) I, only
2) II, only
3) I and III
4) III and IV

417 A ball is dropped from a height of 32 feet. It bounces and rebounds 80% of the height from which it was falling. What is the total downward distance, in feet, the ball traveled up to the 12th bounce?
1) 29
2) 58
3) 120
4) 149

418 The solutions to the equation $\frac{1}{2}x^2 = -6x + 20$ are
1) $-6 \pm 2i$
2) $-6 \pm 2\sqrt{19}$
3) $6 \pm 2i$
4) $6 \pm 2\sqrt{19}$
419 In contract negotiations between a local government agency and its workers, it is estimated that there is a 50% chance that an agreement will be reached on the salaries of the workers. It is estimated that there is a 70% chance that there will be an agreement on the insurance benefits. There is a 20% chance that no agreement will be reached on either issue. Find the probability that an agreement will be reached on both issues. Based on this answer, determine whether the agreement on salaries and the agreement on insurance are independent events. Justify your answer.

420 a) On the axes below, sketch at least one cycle of a sine curve with an amplitude of 2, a midline at \( y = -\frac{3}{2} \), and a period of \( 2\pi \).

\[
\begin{array}{c}
\text{y} \\
\text{x}
\end{array}
\]

b) Explain any differences between a sketch of \( y = 2\sin\left(x - \frac{\pi}{3}\right) - \frac{3}{2} \) and the sketch from part a.

421 A rabbit population doubles every 4 weeks. There are currently five rabbits in a restricted area. If \( t \) represents the time, in weeks, and \( P(t) \) is the population of rabbits with respect to time, about how many rabbits will there be in 98 days?
1) 56
2) 152
3) 3688
4) 81,920

422 A suburban high school has a population of 1376 students. The number of students who participate in sports is 649. The number of students who participate in music is 433. If the probability that a student participates in either sports or music is \( \frac{974}{1376} \), what is the probability that a student participates in both sports and music?

423 Algebraically solve the following system of equations.
\[
(x - 2)^2 + (y - 3)^2 = 16 \\
x + y - 1 = 0
\]

424 The value of a new car depreciates over time. Greg purchased a new car in June 2011. The value, \( V \), of his car after \( t \) years can be modeled by the equation \( \log_{0.8}\left(\frac{V}{17000}\right) = t \). What is the average decreasing rate of change per year of the value of the car from June 2012 to June 2014, to the nearest ten dollars per year?
1) 1960
2) 2180
3) 2450
4) 2770
425 The table below gives air pressures in kPa at selected altitudes above sea level measured in kilometers.

<table>
<thead>
<tr>
<th>x</th>
<th>Altitude (km)</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>y</td>
<td>Air Pressure (kPa)</td>
<td>101</td>
<td>90</td>
<td>79</td>
<td>70</td>
<td>62</td>
<td>54</td>
</tr>
</tbody>
</table>

Write an exponential regression equation that models these data rounding all values to the nearest thousandth. Use this equation to algebraically determine the altitude, to the nearest hundredth of a kilometer, when the air pressure is 29 kPa.

426 Elaina has decided to run the Buffalo half-marathon in May. She researched training plans on the Internet and is looking at two possible plans: Jillian’s 12-week plan and Josh’s 14-week plan. The number of miles run per week for each plan is plotted below.

Which one of the plans follows an arithmetic pattern? Explain how you arrived at your answer. Write a recursive definition to represent the number of miles run each week for the duration of the plan you chose. Jillian’s plan has an alternative if Elaina wanted to train instead for a full 26-mile marathon. Week one would start at 13 miles and follow the same pattern for the half-marathon, but it would continue for 14 weeks. Write an explicit formula, in simplest form, to represent the number of miles run each week for the full-marathon training plan.
Seventy-two students are randomly divided into two equally-sized study groups. Each member of the first group (group 1) is to meet with a tutor after school twice each week for one hour. The second group (group 2), is given an online subscription to a tutorial account that they can access for a maximum of two hours each week. Students in both groups are given the same tests during the year. A summary of the two groups’ final grades is shown below:

<table>
<thead>
<tr>
<th></th>
<th>Group 1</th>
<th>Group 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>$x$</td>
<td>80.16</td>
<td>83.8</td>
</tr>
<tr>
<td>$S_x$</td>
<td>6.9</td>
<td>5.2</td>
</tr>
</tbody>
</table>

Calculate the mean difference in the final grades (group 1 – group 2) and explain its meaning in the context of the problem. A simulation was conducted in which the students’ final grades were rerandomized 500 times. The results are shown below.

Use the simulation to determine if there is a significant difference in the final grades. Explain your answer.

Solve for all values of $p$: \[
\frac{3p}{p - 5} - \frac{2}{p + 3} = \frac{p}{p + 3}
\]

Algebraically determine the values of $h$ and $k$ to correctly complete the identity stated below.

\[
2x^3 - 10x^2 + 11x - 7 = (x - 4)(2x^2 + hx + 3) + k
\]

The probability that Gary and Jane have a child with blue eyes is 0.25, and the probability that they have a child with blond hair is 0.5. The probability that they have a child with both blue eyes and blond hair is 0.125. Given this information, the events blue eyes and blond hair are

1) I, only
2) II, only
3) I and III
4) II and III
431. What is the inverse of the function \( y = \log_3 x \)?

1) \( y = x^3 \)
2) \( y = \log_3 x \)
3) \( y = 3^x \)
4) \( x = 3^y \)

434. Given: \( h(x) = \frac{2}{9} x^3 + \frac{8}{9} x^2 - \frac{16}{13} x + 2 \)

\[ k(x) = -0.7x + 5 \]

State the solutions to the equation \( h(x) = k(x) \), rounded to the nearest hundredth.

435. Which scenario is best described as an observational study?

1) For a class project, students in Health class ask every tenth student entering the school if they eat breakfast in the morning.
2) A social researcher wants to learn whether or not there is a link between attendance and grades. She gathers data from 15 school districts.
3) A researcher wants to learn whether or not there is a link between children's daily amount of physical activity and their overall energy level. During lunch at the local high school, she distributed a short questionnaire to students in the cafeteria.
4) Sixty seniors taking a course in Advanced Algebra Concepts are randomly divided into two classes. One class uses a graphing calculator all the time, and the other class never uses graphing calculators. A guidance counselor wants to determine whether there is a link between graphing calculator use and students' final exam grades.

436. The sequence \( a_1 = 6, a_n = 3a_{n-1} \) can also be written as

1) \( a_n = 6 \cdot 3^n \)
2) \( a_n = 6 \cdot 3^{n-1} \)
3) \( a_n = 2 \cdot 3^n \)
4) \( a_n = 2 \cdot 3^{n-1} \)
437 Fifty-five students attending the prom were randomly selected to participate in a survey about the music choice at the prom. Sixty percent responded that a DJ would be preferred over a band. Members of the prom committee thought that the vote would have 50% for the DJ and 50% for the band. A simulation was run 200 times, each of sample size 55, based on the premise that 60% of the students would prefer a DJ. The approximate normal simulation results are shown below.

Using the results of the simulation, determine a plausible interval containing the middle 95% of the data. Round all values to the nearest hundredth. Members of the prom committee are concerned that a vote of all students attending the prom may produce a 50%–50% split. Explain what statistical evidence supports this concern.

438 Which equation represents a parabola with a focus of (0, 4) and a directrix of \( y = 2 \)?

1) \( y = x^2 + 3 \)
2) \( y = -x^2 + 1 \)
3) \( y = \frac{x^2}{2} + 3 \)
4) \( y = \frac{x^2}{4} + 3 \)

439 Given the geometric series \( 300 + 360 + 432 + 518.4 + \ldots \), write a geometric series formula, \( S_n \), for the sum of the first \( n \) terms. Use the formula to find the sum of the first 10 terms, to the nearest tenth.

440 Julie averaged 85 on the first three tests of the semester in her mathematics class. If she scores 93 on each of the remaining tests, her average will be 90. Which equation could be used to determine how many tests, \( T \), are left in the semester?

1) \( \frac{255 + 93T}{3T} = 90 \)
2) \( \frac{255 + 90T}{3T} = 93 \)
3) \( \frac{255 + 93T}{T+3} = 90 \)
4) \( \frac{255 + 90T}{T+3} = 93 \)

441 A student studying public policy created a model for the population of Detroit, where the population decreased 25% over a decade. He used the model \( P = 714(0.75)^d \), where \( P \) is the population, in thousands, \( d \) decades after 2010. Another student, Suzanne, wants to use a model that would predict the population after \( y \) years. Suzanne's model is best represented by

1) \( P = 714(0.6500)^y \)
2) \( P = 714(0.8500)^y \)
3) \( P = 714(0.9716)^y \)
4) \( P = 714(0.9750)^y \)
The set of data in the table below shows the results of a survey on the number of messages that people of different ages text on their cell phones each month.

<table>
<thead>
<tr>
<th>Age Group</th>
<th>0-10</th>
<th>11-50</th>
<th>Over 50</th>
</tr>
</thead>
<tbody>
<tr>
<td>15-18</td>
<td>4</td>
<td>37</td>
<td>68</td>
</tr>
<tr>
<td>19-22</td>
<td>6</td>
<td>25</td>
<td>87</td>
</tr>
<tr>
<td>23-60</td>
<td>25</td>
<td>47</td>
<td>157</td>
</tr>
</tbody>
</table>

If a person from this survey is selected at random, what is the probability that the person texts over 50 messages per month given that the person is between the ages of 23 and 60?

1) \( \frac{157}{229} \)  
2) \( \frac{157}{312} \)  
3) \( \frac{157}{384} \)  
4) \( \frac{157}{456} \)

Joelle has a credit card that has a 19.2% annual interest rate compounded monthly. She owes a total balance of \( B \) dollars after \( m \) months. Assuming she makes no payments on her account, the table below illustrates the balance she owes after \( m \) months.

<table>
<thead>
<tr>
<th>( m )</th>
<th>( B )</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>100.00</td>
</tr>
<tr>
<td>10</td>
<td>1172.00</td>
</tr>
<tr>
<td>19</td>
<td>1352.00</td>
</tr>
<tr>
<td>36</td>
<td>1770.80</td>
</tr>
<tr>
<td>60</td>
<td>2591.90</td>
</tr>
<tr>
<td>69</td>
<td>2990.00</td>
</tr>
<tr>
<td>72</td>
<td>3135.80</td>
</tr>
<tr>
<td>73</td>
<td>3186.00</td>
</tr>
</tbody>
</table>

Over which interval of time is her average rate of change for the balance on her credit card account the greatest?

1) month 10 to month 60  
2) month 19 to month 69  
3) month 36 to month 72  
4) month 60 to month 73

Solve the equation \( \sqrt{2x - 7} + x = 5 \) algebraically, and justify the solution set.

Show why \( x - 3 \) is a factor of \( m(x) = x^3 - x^2 - 5x - 3 \). Justify your answer.
446 On the grid below, sketch a cubic polynomial whose zeros are 1, 3, and -2.

447 Two versions of a standardized test are given, an April version and a May version. The statistics for the April version show a mean score of 480 and a standard deviation of 24. The statistics for the May version show a mean score of 510 and a standard deviation of 20. Assume the scores are normally distributed. Joanne took the April version and scored in the interval 510-540. What is the probability, to the nearest ten thousandth, that a test paper selected at random from the April version scored in the same interval? Maria took the May version. In what interval must Maria score to claim she scored as well as Joanne?

448 Describe the transformation applied to the graph of \( p(x) = 2^x \) that forms the new function \( q(x) = 2^{x-3} + 4 \).

449 As \( x \) increases from 0 to \( \frac{\pi}{2} \), the graph of the equation \( y = 2 \tan x \) will
1) increase from 0 to 2
2) decrease from 0 to -2
3) increase without limit
4) decrease without limit

450 Which diagram shows an angle rotation of 1 radian on the unit circle?
451 Which equation represents the set of points equidistant from line $\ell$ and point $R$ shown on the graph below?

![Graph with line $\ell$ and point $R$]

1) $y = -\frac{1}{8}(x+2)^2 + 1$
2) $y = -\frac{1}{8}(x+2)^2 - 1$
3) $y = -\frac{1}{8}(x-2)^2 + 1$
4) $y = -\frac{1}{8}(x-2)^2 - 1$

452 Mallory wants to buy a new window air conditioning unit. The cost for the unit is $329.99. If she plans to run the unit three months out of the year for an annual operating cost of $108.78$, which function models the cost per year over the lifetime of the unit, $C(n)$, in terms of the number of years, $n$, that she owns the air conditioner.

1) $C(n) = 329.99 + 108.78n$
2) $C(n) = 329.99 + 326.34n$
3) $C(n) = \frac{329.99 + 108.78n}{n}$
4) $C(n) = \frac{329.99 + 326.34n}{n}$

453 A solution of the equation $2x^2 + 3x + 2 = 0$ is

1) $\frac{3}{4} + \frac{1}{4}i\sqrt{7}$
2) $\frac{3}{4} + \frac{1}{4}i$
3) $\frac{3}{4} + \frac{1}{4}\sqrt{7}$
4) $\frac{1}{2}$

454 The price of a postage stamp in the years since the end of World War I is shown in the scatterplot below.

![Price of a Postage Stamp Since End of World War I]

The equation that best models the price, in cents, of a postage stamp based on these data is

1) $y = 0.59x - 14.82$
2) $y = 1.04(1.43)^x$
3) $y = 1.43(1.04)^x$
4) $y = 24\sin(14x) + 25$
455 The parabola \( y = -\frac{1}{20} (x - 3)^2 + 6 \) has its focus at (3, 1). Determine and state the equation of the directrix. (The use of the grid below is optional.)

456 Solve the following system of equations algebraically for all values of \( x \), \( y \), and \( z \):
\[
\begin{align*}
    x + 3y + 5z &= 45 \\
    6x - 3y + 2z &= -10 \\
    -2x + 3y + 8z &= 72
\end{align*}
\]

457 The eighth and tenth terms of a sequence are 64 and 100. If the sequence is either arithmetic or geometric, the ninth term can *not* be
1) \(-82\)  
2) \(-80\)  
3) \(80\)  
4) \(82\)

458 What is the solution, if any, of the equation
\[
\frac{2}{x + 3} - \frac{3}{4 - x} = \frac{2x - 2}{x^2 - x - 12}?
\]
1) \(-1\)  
2) \(-5\)  
3) all real numbers  
4) no real solution

459 The expression \( \frac{-3x^2 - 5x + 2}{x^3 + 2x^2} \) can be rewritten as
1) \(\frac{-3x - 3}{x^2 + 2x}\)  
2) \(\frac{-3x - 1}{x^2}\)  
3) \(-3x^{-1} + 1\)  
4) \(-3x^{-1} + x^{-2}\)

460 Sally’s high school is planning their spring musical. The revenue, \( R \), generated can be determined by the function \( R(t) = -33t^2 + 360t \), where \( t \) represents the price of a ticket. The production cost, \( C \), of the musical is represented by the function \( C(t) = 700 + 5t \). What is the highest ticket price, to the nearest dollar, they can charge in order to *not* lose money on the event?
1) \(t = 3\)  
2) \(t = 5\)  
3) \(t = 8\)  
4) \(t = 11\)
461 Which graph has the following characteristics?
- three real zeros
- as \( x \to -\infty \), \( f(x) \to -\infty \)
- as \( x \to \infty \), \( f(x) \to \infty \)

1)  

2)  

3)  

4)  

462 Which function represents exponential decay?
1) \( y = 2^{0.3t} \)
2) \( y = 1.2^t \)
3) \( y = \left( \frac{1}{2} \right)^{-t} \)
4) \( y = 5^{-t} \)

463 Cheap and Fast gas station is conducting a consumer satisfaction survey. Which method of collecting data would most likely lead to a biased sample?
1) interviewing every 5th customer to come into the station
2) interviewing customers chosen at random by a computer at the checkout
3) interviewing customers who call an 800 number posted on the customers' receipts
4) interviewing every customer who comes into the station on a day of the week chosen at random out of a hat

464 Using the formula below, determine the monthly payment on a 5-year car loan with a monthly percentage rate of 0.625% for a car with an original cost of $21,000 and a $1000 down payment, to the nearest cent.

\[
P_n = PMT \left( \frac{1 - (1 + i)^{-n}}{i} \right)
\]

\( P_n \) = present amount borrowed  
\( n \) = number of monthly pay periods  
\( PMT \) = monthly payment  
\( i \) = interest rate per month

The affordable monthly payment is $300 for the same time period. Determine an appropriate down payment, to the nearest dollar.
465 The completely factored form of 
\[2d^4 + 6d^3 - 18d^2 - 54d\] is

1) \[2d(d^2 - 9)(d + 3)\]
2) \[2d(d^2 + 9)(d + 3)\]
3) \[2d(d + 3)^2 (d - 3)\]
4) \[2d(d - 3)^2 (d + 3)\]

466 Which graph represents a cosine function with no horizontal shift, an amplitude of 2, and a period of \(\frac{2\pi}{3}\)?

467 The weight of a bag of pears at the local market averages 8 pounds with a standard deviation of 0.5 pound. The weights of all the bags of pears at the market closely follow a normal distribution. Determine what percentage of bags, to the nearest integer, weighed less than 8.25 pounds.

468 The ocean tides near Carter Beach follow a repeating pattern over time, with the amount of time between each low and high tide remaining relatively constant. On a certain day, low tide occurred at 8:30 a.m. and high tide occurred at 3:00 p.m. At high tide, the water level was 12 inches above the average local sea level; at low tide it was 12 inches below the average local sea level. Assume that high tide and low tide are the maximum and minimum water levels each day, respectively. Write a cosine function of the form \(f(t) = A \cos(Bt)\), where \(A\) and \(B\) are real numbers, that models the water level, \(f(t)\), in inches above or below the average Carter Beach sea level, as a function of the time measured in \(t\) hours since 8:30 a.m. On the grid below, graph one cycle of this function.

People who fish in Carter Beach know that a certain species of fish is most plentiful when the water level is increasing. Explain whether you would recommend fishing for this species at 7:30 p.m. or 10:30 p.m. using evidence from the given context.
469. The loudness of sound is measured in units called decibels (dB). These units are measured by first assigning an intensity \( I_0 \) to a very soft sound that is called the threshold sound. The sound to be measured is assigned an intensity, \( I \), and the decibel rating, \( d \), of this sound is found using \( d = 10 \log \frac{I}{I_0} \). The threshold sound audible to the average person is \( 1.0 \times 10^{-12} \) W/m\(^2\) (watts per square meter). Consider the following sound level classifications:

<table>
<thead>
<tr>
<th>Sound Level</th>
<th>Decibel Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moderate</td>
<td>45-69 dB</td>
</tr>
<tr>
<td>Loud</td>
<td>70-89 dB</td>
</tr>
<tr>
<td>Very loud</td>
<td>90-109 dB</td>
</tr>
<tr>
<td>Deafening</td>
<td>&gt;110 dB</td>
</tr>
</tbody>
</table>

How would a sound with intensity \( 6.3 \times 10^{-3} \) W/m\(^2\) be classified?
1) moderate  
2) loud  
3) very loud  
4) deafening

470. Sarah is fighting a sinus infection. Her doctor prescribed a nasal spray and an antibiotic to fight the infection. The active ingredients, in milligrams, remaining in the bloodstream from the nasal spray, \( n(t) \), and the antibiotic, \( a(t) \), are modeled in the functions below, where \( t \) is the time in hours since the medications were taken.

\[
n(t) = \frac{t+1}{t+5} + \frac{18}{t^2 + 8t + 15}
\]

\[
a(t) = \frac{9}{t+3}
\]

Determine which drug is made with a greater initial amount of active ingredient. Justify your answer. Sarah's doctor told her to take both drugs at the same time. Determine algebraically the number of hours after taking the medications when both medications will have the same amount of active ingredient remaining in her bloodstream.

471. Which expression is equivalent to \((3k - 2i)^2\), where \( i \) is the imaginary unit?
1) \( 9k^2 - 4 \)
2) \( 9k^2 + 4 \)
3) \( 9k^2 - 12ki - 4 \)
4) \( 9k^2 - 12ki + 4 \)

472. Mr. Farison gave his class the three mathematical rules shown below to either prove or disprove. Which rules can be proved for all real numbers?

I \( (m + p)^2 = m^2 + 2mp + p^2 \)

II \( (x + y)^3 = x^3 + 3xy + y^3 \)

III \( (a^2 + b^2)^2 = (a^2 - b^2)^2 + (2ab)^2 \)

1) I, only  
2) I and II  
3) II and III  
4) I and III
473. An orange-juice processing plant receives a truckload of oranges. The quality control team randomly chooses three pails of oranges, each containing 50 oranges, from the truckload. Identify the sample and the population in the given scenario. State one conclusion that the quality control team could make about the population if 5% of the sample was found to be unsatisfactory.

474. The solution to the equation $4x^2 + 98 = 0$ is
1) $\pm 7$
2) $\pm 7i$
3) $\pm \frac{7\sqrt{2}}{2}$
4) $\pm \frac{7i\sqrt{2}}{2}$

475. Which expression is equivalent to $\frac{4x^3 + 9x - 5}{2x - 1}$, where $x \neq \frac{1}{2}$?
1) $2x^2 + x + 5$
2) $2x^2 + \frac{11}{2} + \frac{1}{2(2x - 1)}$
3) $2x^2 - x + 5$
4) $2x^2 - x + 4 + \frac{1}{2x - 1}$
Algebra II Regents at Random Worksheets
Answer Section

1 ANS: 1 PTS: 2 REF: 081813aii NAT: A.SSE.B.4
TOP: Series

2 ANS:
q has the smaller minimum value for the domain \([-2,2]\). h’s minimum is \(-1 \left(2(-1) + 1\right)\) and q’s minimum is \(-8\).

3 ANS: 1 PTS: 2 REF: 011830aii NAT: F.IF.C.9 TOP: Comparing Functions
TOP: Families of Functions

4 ANS: 4
\[5000\left(1 + \frac{.035}{12}\right)^{12 \cdot 6} \approx 6166.50\]

5 ANS: 4
\[3x - (-2x + 14) = 16 \quad 3(6) - 4z = 2\]
\[5x = 30 \quad -4z = -16\]
\[x = 6 \quad z = 4\]

6 ANS:
\[\sqrt{6 - 2x + x} = 2x + 30 - 9 \quad \sqrt{6 - 2(-29)} \neq -29 + 21, \text{ so } -29 \text{ is extraneous.}\]
\[\sqrt{6 - 2x} = x + 21 \quad \sqrt{64} \neq -8\]
\[6 - 2x = x^2 + 42x + 441\]
\[x^2 + 44x + 435 = 0\]
\[(x + 29)(x + 15) = 0\]
\[x = -29, -15\]

7 ANS: 4
1 year = 365 days

PTS: 2 REF: 061823aii NAT: A.SSE.B.3 TOP: Modeling Exponential Functions
8 ANS:
\[
\frac{p(x)}{x - 1} = x^2 + 7 + \frac{5}{x - 1}
\]
\[
p(x) = x^3 - x^2 + 7x - 7 + 5
\]
\[
p(x) = x^3 - x^2 + 7x - 2
\]

PTS: 2  REF: 061930aii  NAT: A.APR.D.6  TOP: Rational Expressions
KEY: division

9 ANS: 1
\[
6 - (3x - 2i)(3x - 2i) = 6 - \left(9x^2 - 12xi + 4i^2\right) = 6 - 9x^2 + 12xi + 4 = -9x^2 + 12xi + 10
\]

PTS: 2  REF: 061915aii  NAT: N.CN.A.2  TOP: Operations with Complex Numbers

10 ANS: 1
\[
2000 \left(1 + \frac{0.032}{12}\right)^{12t} \approx 2000(1.003)^{12t}
\]

PTS: 2  REF: 012004aii  NAT: F.BF.A.1  TOP: Modeling Exponential Functions

11 ANS:
\[
\frac{h(2) - h(1)}{2 - 1} = -12, \quad h(t) = 0 \text{ at } t \approx 2.2, 3.8, \text{ using a graphing calculator to find where } h(t) = 0.
\]

PTS: 4  REF: 061836aii  NAT: F.IF.B.4  TOP: Graphing Trigonometric Functions

12 ANS:
The denominator of the rational exponent represents the index of a root, and the numerator of the rational exponent represents the power of the base. \(\sqrt[5]{9} = 243\)

PTS: 2  REF: 081926aii  NAT: N.RN.A.1  TOP: Radicals and Rational Exponents

13 ANS: 2  PTS: 2  REF: 061804aii  NAT: S.ID.B.6  TOP: Regression  KEY: choose model

14 ANS:
\[
a_1 = 4
\]
\[
a_n = 3a_{n-1}
\]

PTS: 2  REF: 081931aii  NAT: F.LE.A.2  TOP: Sequences
KEY: recursive

15 ANS: 1  PTS: 2  REF: 081804aii  NAT: F.IF.C.9  TOP: Comparing Functions

16 ANS: 4
\[
400 \cdot 0.954 \approx 380
\]

PTS: 2  REF: 061918aii  NAT: S.ID.A.4  TOP: Normal Distributions
KEY: predict
17  ANS: 3
\[ y = 278(0.5)^{18} \approx 0.271 \]

PTS: 2  REF: 011920aii  NAT: F.LE.A.2  TOP: Modeling Exponential Functions

18  ANS: 1
\[ \frac{x(x^2 - 9)}{-(x^2 - 9)} = -x \]

PTS: 2  REF: 012023aii  NAT: A.APR.D.6  TOP: Rational Expressions

KEY: factoring

19  ANS: 4
\[ 1 + \frac{.009}{12} = 1.00075 \]

PTS: 2  REF: 011918aii  NAT: A.SSE.B.3  TOP: Modeling Exponential Functions

20  ANS:
\[ s(t) = 200(0.5)^{\frac{t}{15}} \]
\[ \frac{1}{10} = (0.5)^{\frac{t}{15}} \]
\[ \log \frac{1}{10} = \log(0.5)^{\frac{t}{15}} \]
\[ -1 = \frac{t \cdot \log(0.5)}{15} \]
\[ t = \frac{-15}{\log(0.5)} \approx 50 \]

PTS: 4  REF: 061934aii  NAT: F.LE.A.4  TOP: Exponential Decay

21  ANS: 2
\[ S_{20} = \frac{.01 - .01(3)^{20}}{1 - 3} = 17,433,922 \]

PTS: 2  REF: 011822aii  NAT: A.SSE.B.4  TOP: Series

22  ANS:
The denominator of the rational exponent represents the index of a root, and the 4th root of 81 is 3 and 3^3 is 27.

PTS: 2  REF: 011832aii  NAT: N.RN.A.1  TOP: Radicals and Rational Exponents

23  ANS: 3
\[ (x + 3i)^2 - (2x - 3i)^2 = x^2 + 6xi + 9i^2 - \left( 4x^2 - 12xi + 9i^2 \right) = -3x^2 + 18xi \]

PTS: 2  REF: 061805aii  NAT: N.CN.A.2  TOP: Operations with Complex Numbers
24 ANS: 4

\[
\frac{5x^2 + x - 3}{2x - 1} = \frac{10x^3 - 3x^2 - 7x + 3}{10x^3 - 5x^2}
\]

\[
\frac{2x^2 - 7x}{x^2 - x}
\]

\[
-6x + 3
\]

\[
-6x + 3
\]

PTS: 2 REF: 011809aii NAT: A.APR.D.6 TOP: Rational Expressions

KEY: division

25 ANS: 3

\[
x^2 - 4x - 5 = 4x^2 - 40x + 100
\]

\[
3x^2 - 36x + 105 = 0
\]

\[
x^2 - 12x + 35 = 0
\]

\[
(x - 7)(x - 5) = 0
\]

\[
x = 5, 7
\]

PTS: 2 REF: 081807aii NAT: A.REI.A.2 TOP: Solving Radicals

KEY: extraneous solutions

26 ANS: 3

\[
1.04^{\frac{1}{12}} \approx 1.0032737
\]

PTS: 2 REF: 011906aii NAT: A.SSE.B.3 TOP: Modeling Exponential Functions

27 ANS: 3

\[
\frac{2x^3 - 4x^2 - x + \frac{14}{x + 6}}{x + 6} = \frac{2x^4 + 8x^3 - 25x^2 - 6x + 14}{2x^4 + 12x^3}
\]

\[
-4x^3 - 25x^2
\]

\[
-4x^3 - 24x^2
\]

\[
-x^2 - 6x
\]

\[
-x^2 - 6x
\]

PTS: 2 REF: 081805aii NAT: A.APR.D.6 TOP: Rational Expressions

KEY: division
28 ANS: 3
\[(x + a)^2 + 5(x + a) + 4 \text{ let } u = x + a\]
\[u^2 + 5u + 4\]
\[(u + 4)(u + 1)\]
\[(x + a + 4)(x + a + 1)\]

PTS: 2 REF: 012006aii NAT: A.SSE.A.2 TOP: Factoring Polynomials
KEY: multivariable

29 ANS: 3
\[8r^3 = 216 \quad S_{12} = \frac{8 - 8(3)^{12}}{1 - 3} = 2125760\]
\[r^3 = 27\]
\[r = 3\]

PTS: 2 REF: 081902aii NAT: A.SSE.B.4 TOP: Series

30 ANS: 3
\[T(19) = 8 \sin(0.3(19) - 3) + 74 \approx 77\]

PTS: 2 REF: 061922aii NAT: F.TF.A.2 TOP: Determining Trigonometric Functions
KEY: radians

31 ANS:
\[29.101 \pm 2 \cdot 0.934 = 27.23 - 30.97. \text{ Yes, since } 30 \text{ falls within the 95\% interval.}\]

PTS: 4 REF: 011935aii NAT: S.IC.A.2 TOP: Analysis of Data

32 ANS: 1
\[x - \frac{4}{x - 1} = 2 \quad x = \frac{3 \pm \sqrt{(-3)^2 - 4(1)(-2)}}{2(1)} = \frac{3 \pm \sqrt{17}}{2}\]
\[x(x - 1) - 4 = 2(x - 1)\]
\[x^2 - x - 4 = 2x - 2\]
\[x^2 - 3x - 2 = 0\]

PTS: 2 REF: 011812aii NAT: A.REI.A.2 TOP: Solving Rationals
KEY: rational solutions

33 ANS: 3 PTS: 2 REF: 081819aii NAT: A.REI.D.11
TOP: Other Systems

34 ANS: 2
(1) 0.4 \cdot 0.3 \neq 0.2, (2) 0.8 \cdot 0.25 = 0.2, (3) \(P(A|B) = P(A) = 0.2, \) (4) \(0.2 \neq 0.15 \cdot 0.05\)
\[0.2 \neq 0.2 \cdot 0.2\]

PTS: 2 REF: 011912aii NAT: S.CP.A.3 TOP: Conditional Probability

35 ANS: 4 PTS: 2 REF: 011808aii NAT: A.SSE.B.3
TOP: Modeling Exponential Functions
36 ANS: 3

The vertex is \((-3, 5)\) and \(p = 2\). \(y = \frac{-1}{4(2)}(x + 3)^2 + 5\)

PTS: 2 REF: 011914aii NAT: G.GPE.A.2 TOP: Graphing Quadratic Functions

37 ANS: 4

\[\log_2 (x - 1) - 1 = 0\]

\[\log_2 (x - 1) = 1\]

\[x - 1 = 2^1\]

\[x = 3\]

PTS: 2 REF: 061819aii NAT: F.IF.C.7 TOP: Graphing Logarithmic Functions

38 ANS: 1

\[x - \frac{20}{x} = 8\]

\[x^2 - 8x - 20 = 0\]

\[(x - 10)(x + 2) = 0\]

\[x = 10, -2\]

PTS: 2 REF: 061916aii NAT: A.CED.A.1 TOP: Modeling Rationals

39 ANS:

\[\frac{1}{8} + \frac{1}{6} = \frac{1}{t_b}, \quad \frac{24t_b}{8} + \frac{24t_b}{6} = \frac{24t_b}{t_b}\]

\[3t_b + 4t_b = 24\]

\[t_b = \frac{24}{7} \approx 3.4\]

PTS: 2 REF: 011827aii NAT: A.CED.A.1 TOP: Modeling Rationals

40 ANS: 4

\[\frac{5 + 9}{2} = 7, \text{ vertex: } (-2, 7); \quad p = 7 - 9 = -2, \quad y = \frac{1}{4(-2)}(x + 2)^2 + 7\]

\[y - 7 = \frac{1}{-8}(x + 2)^2\]

\[-8(y - 7) = (x + 2)^2\]

PTS: 2 REF: 061821aii NAT: G.GPE.A.2 TOP: Graphing Quadratic Functions
41 ANS: 2
\[ b^2 = 2b^2 - 64 \quad -8 \] is extraneous.

\[ -b^2 = -64 \]

\[ b = \pm 8 \]

PTS: 2  REF: 061919aii  NAT: A.REI.A.2  TOP: Solving Radicals
KEY: extraneous solutions

42 ANS: 1
\[ x + y + z = 9 \quad 4 - y - z = -1 \quad 4 - 6 + z = 9 \]
\[ x - y - z = -1 \quad 4 - y + z = 21 \quad z = 11 \]
\[ 2x = 8 \quad -y - z = -5 \]
\[ x = 4 \quad -y + z = 17 \]
\[ -2y = 12 \]
\[ y = -6 \]

PTS: 2  REF: 012018aii  NAT: A.REI.C.6  TOP: Solving Linear Systems
KEY: three variables

43 ANS: 3
\[ (x + 4)^2 - 10 = 3x + 6 \quad y = 3(-5) + 6 = -9 \]
\[ x^2 + 8x + 16 - 10 = 3x + 6 \quad y = 3(0) + 6 = 6 \]
\[ x^2 + 5x = 0 \]
\[ x(x + 5) = 0 \]
\[ x = -5, 0 \]

PTS: 2  REF: 061903aii  NAT: A.REI.C.7  TOP: Quadratic-Linear Systems

44 ANS: 2  PTS: 2  REF: 081904aii  NAT: A.SSE.A.2  TOP: Factoring Polynomials
KEY: higher power

45 ANS: 3
\[ \sqrt{x + 1} = x + 1 \]
\[ x + 1 = x^2 + 2x + 1 \]
\[ 0 = x^2 + x \]
\[ 0 = x(x + 1) \]
\[ x = -1, 0 \]

PTS: 2  REF: 011802aii  NAT: A.REI.A.2  TOP: Solving Radicals
KEY: extraneous solutions
46 ANS: 1

\[7 - 3i + x^2 - 4xi + 4i^2 - 4i - 2x^2 = 7 - 7i - x^2 - 4xi - 4 = 3 - x^2 - 4xi - 7i = (3 - x^2) - (4x + 7)i\]

PTS: 2  REF: 012022aii  NAT: N.CN.A.2  TOP: Operations with Complex Numbers

47 ANS:

\[4x + 6y - 8z = -2 \quad 4x + 6y - 8z = -2 \quad 4x - 8y + 20z = 12 \quad z + 2 = 3z - 4 \quad y = 3 + 2 \quad -4x + 5 + 3 = 16\]

\[4x - 8y + 20z = 12 \quad -4x + y + z = 16 \quad -4x + y + z = 16 \quad z = 2z = 5 \quad -4x = 8\]

\[-4x + y + z = 16 \quad 7y - 7z = 14 \quad -7y + 21z = 28 \quad z = 3 \quad x = -2\]

\[y - z = 2 \quad y - 3z = -4\]

\[y = z + 2 \quad y = 3z - 4\]

PTS: 4  REF: 081833aii  NAT: A.REI.C.6  TOP: Solving Linear Systems

KEY: three variables

48 ANS: 3

\[e^{bt} = \frac{c}{a}\]

\[\ln e^{bt} = \ln \frac{c}{a}\]

\[bt \ln e = \ln \frac{c}{a}\]

\[t = \frac{\ln \frac{c}{a}}{b}\]

PTS: 2  REF: 011813aii  NAT: F.LE.A.4  TOP: Exponential Growth

49 ANS: 3

\[x^{\frac{2}{3}} \cdot x^{\frac{5}{2}} = x^{\frac{4}{6}} \cdot x^{\frac{15}{6}} = x^{\frac{18}{6}} = x^3\]


KEY: with variables, index > 2

50 ANS: 4

1) quadratic has two roots and both are real \((-2, 0)\) and \((-0.5, 0)\), (2) \(x = \pm \sqrt{32 - 3}\), (3) the real root is 3, with a multiplicity of 2, (4) \(x = \pm 4i\)

PTS: 2  REF: 011909aii  NAT: A.REI.B.4  TOP: Using the Discriminant

KEY: determine nature of roots given equation, graph, table
51 ANS:
\[
\left(2x^2 + x - 3 \right) \cdot (x - 1) - \left[ \left(2x^2 + x - 3 \right) + (x - 1) \right] \\
\left(2x^3 - 2x^2 + x^2 - x - 3x + 3 \right) - \left(2x^2 + 2x - 4 \right) \\
2x^3 - 3x^2 - 6x + 7
\]

PTS: 4 REF: 011833aii NAT: F.BF.A.1 TOP: Operations with Functions

52 ANS: 4
\[
w x^2 + w = 0 \\
w(x^2 + 1) = 0 \\
x^2 = -1 \\
x = \pm i
\]

PTS: 2 REF: 061912aii NAT: A.REI.B.4 TOP: Solving Quadratics
KEY: complex solutions | taking square roots

53 ANS: 1
\[
x^3 + 2x^2 - 9x - 18 = 0 \\
x^3 - 9x + 2x^2 - 18 = 0 \\
x^3 - 9x + 2x^2 - 18 = 0 \\
x^2(x + 2) - 9(x + 2) = 0 \\
x(x^2 - 9) + 2(x^2 - 9) = 0 \\
(x + 2)(x^2 - 9) = 0
\]

PTS: 2 REF: 011903aii NAT: A.APR.B.3 TOP: Solving Polynomial Equations

54 ANS: 2
\[
\text{If } \cos \theta = \frac{7}{25}, \sin \theta = \frac{\pm 24}{25}, \text{ and } \tan \theta = \frac{\sin \theta}{\cos \theta} = \frac{-24}{7} = \frac{-24}{7}
\]

PTS: 2 REF: 081811aii NAT: F.TF.C.8 TOP: Determining Trigonometric Functions

55 ANS: 2
\[
0.254 \pm 2(0.060) \rightarrow (0.134, 0.374)
\]

PTS: 2 REF: 061913aii NAT: S.IC.B.5 TOP: Analysis of Data

56 ANS:
\[
D = 1.223(2.652)^{\Delta}
\]

PTS: 2 REF: 011826aii NAT: S.ID.B.6 TOP: Regression
KEY: exponential
\[ x = \frac{-2 \pm \sqrt{2^2 - 4(3)(7)}}{2(3)} = \frac{-2 \pm \sqrt{-80}}{6} = \frac{-2 \pm i\sqrt{16 \cdot 5}}{6} = \frac{-1}{3} \pm \frac{2i\sqrt{5}}{3} \]

57 ANS: 3

PTS: 2 REF: 081809aii NAT: A.REI.B.4 TOP: Solving Quadratics
KEY: complex solutions | quadratic formula

58 ANS: 3 PTS: 2 REF: 012015aii NAT: S.IC.B.3
TOP: Analysis of Data
KEY: type

59 ANS:
John found the means of the scores of the two rooms and subtracted the means. The mean score for the classical room was 7 higher than the rap room (82-75). Yes, there is less than a 5% chance this difference occurring due to random chance. It is likely the difference was due to the music.

PTS: 4 REF: 081836aii NAT: S.IC.B.5 TOP: Analysis of Data

60 ANS: 4

\[ \ln e^{0.3x} = \ln \frac{5918}{87} \]

\[ \ln \frac{5918}{87} = 0.3 \]

\[ x = \frac{0.3}{e} \]

PTS: 2 REF: 081801aii NAT: F.LE.A.4 TOP: Exponential Equations
KEY: without common base

61 ANS: 2 PTS: 2 REF: 081911aii NAT: F.BF.B.3
TOP: Even and Odd Functions

62 ANS:
0.301 \pm 2(0.058) \rightarrow 0.185 - 0.417 \approx 0.23. It is not unusual because 0.23 falls within this interval.

PTS: 4 REF: 081935aii NAT: S.IC.B.5 TOP: Analysis of Data

63 ANS:
\[ P(F|L) = \frac{12}{27} \quad P(F) = \frac{22}{45} \quad \text{Since } P(F|L) \neq P(F), \text{ the events are not independent.} \]

PTS: 4 REF: 061936aii NAT: S.CP.A.4 TOP: Conditional Probability

64 ANS: 3 PTS: 2 REF: 011824aii NAT: F.BF.A.2
TOP: Sequences
65 ANS: 2
\[
\frac{2 - \frac{x - 1}{x + 2}}{1 + \frac{x + 2}{x + 2} - \frac{x - 1}{x + 2}}
\]
\[
\frac{1 + \frac{x + 2 - (x - 1)}{x + 2}}{1 + \frac{3}{x + 2}}
\]

PTS: 2
REF: 081907a
NAT: A.APR.D.7
TOP: Addition and Subtraction of Rationals

66 ANS: 4
\[
\frac{\frac{1}{52}}{1.06}
\]

PTS: 2
REF: 061924a
NAT: F.BF.A.1
TOP: Modeling Exponential Functions

67 ANS: 1
\[
\frac{\frac{3}{x^2}}{x^3}
\]

PTS: 2
REF: 061908a
NAT: N.RN.A.2
TOP: Radicals and Rational Exponents

KEY: variables

68 ANS: 4

PTS: 2
REF: 081824a
NAT: S.CP.A.3
TOP: Conditional Probability

69 ANS:
\[
t^2 + \left(\frac{4}{7}\right)^2 = 1
\]
\[
t^2 = 1 - \frac{4}{49} = \frac{45}{49}
\]
\[
t = \pm \sqrt{\frac{45}{49}}
\]

PTS: 2
REF: 011931a
NAT: F.TF.A.2
TOP: Unit Circle

70 ANS: 4
\[
(a + b + c)^2 = a^2 + ab + ac + ab + b^2 + bc + ac + ab + c^2
\]
\[
x = a^2 + b^2 + c^2 + 2(ab + bc + ac)
\]
\[
x = y + 2z
\]

PTS: 2
REF: 061822a
NAT: A.APR.C.4
TOP: Polynomial Identities
71 ANS: 4
\[ f(x) = (x + 1)(x - 1)(x - 2) = (x^2 - 1)(x - 2) = x^3 - 2x^2 - x + 2 \]

PTS: 2 REF: 081921aii NAT: A.APR.B.3 TOP: Graphing Polynomial Functions

72 ANS: 2
\[ u = x + 2 \quad u^2 + 4u + 3 \]
\[ (u + 3)(u + 1) \]
\[ (x + 2 + 3)(x + 2 + 1) \]
\[ (x + 5)(x + 3) \]

PTS: 2 REF: 081901aii NAT: A.SSE.A.2 TOP: Factoring Polynomials
KEY: higher power

73 ANS: 2
\[ x^2 + 4x - 1 = x - 3 \quad y + 3 = -1 \]
\[ x^2 + 3x + 2 = 0 \quad y = -4 \]
\[ (x + 2)(x + 1) = 0 \]
\[ x = -2, -1 \]

PTS: 2 REF: 061801aii NAT: A.REI.C.7 TOP: Quadratic-Linear Systems

74 ANS: 4 PTS: 2 REF: 081810aii NAT: F.BF.A.2 TOP: Sequences

75 ANS: 1

PTS: 2 REF: 011908aii NAT: F.IF.B.4 TOP: Graphing Polynomial Functions
\[
\frac{2}{3x + 1} = \frac{1}{x} - \frac{6x}{3x + 1} - \frac{1}{3} \quad \text{is extraneous.}
\]

\[
\frac{6x + 2}{3x + 1} = \frac{1}{x}
\]

\[6x^2 + 2x = 3x + 1\]

\[6x^2 - x - 1 = 0\]

\[(2x - 1)(3x + 1) = 0\]

\[x = \frac{1}{2}, -\frac{1}{3}\]

**PTS:** 2 \n**REF:** 011915aii \n**NAT:** A.REI.A.2 \n**TOP:** Solving Rationals

\[
(x^6 y^4 - 9)(x^4 - 16)
\]

\[
(x^3 y^2 + 3)(x^3 y^2 - 3)(x^2 + 4)(x^2 - 4)
\]

**PTS:** 2 \n**REF:** 081814aii \n**NAT:** A.SSE.A.2 \n**TOP:** Factoring Polynomials

**KEY:** factoring by grouping

\[i^2 = -1, \text{ and not } 1; \quad 10 + 10i\]

**PTS:** 2 \n**REF:** 011825aii \n**NAT:** N.CN.A.2 \n**TOP:** Operations with Complex Numbers

**TOP:** Other Systems

\[
-\frac{12}{16} = \frac{9}{-12} = -\frac{6.75}{9}
\]

**PTS:** 2 \n**REF:** 012017aii \n**NAT:** F.IF.A.3 \n**TOP:** Sequences

**KEY:** difference or ratio

\[
\frac{c^2 - d^2}{d^2 + cd - 2c^2} = \frac{(c + d)(c - d)}{(d + 2c)(d - c)} = \frac{-c + d}{d + 2c} = \frac{-c - d}{d + 2c}
\]

**PTS:** 2 \n**REF:** 011818aii \n**NAT:** A.APR.D.6 \n**TOP:** Rational Expressions

**KEY:** factoring
82 ANS: 
\[
\frac{7}{2x} - \frac{2}{x+1} = \frac{1}{4}
\]
\[
\frac{7x + 7 - 4x}{2x^2 + 2x} = \frac{1}{4}
\]
\[
2x^2 + 2x = 12x + 28
\]
\[
x^2 - 5x - 14 = 0
\]
\[
(x - 7)(x + 2) = 0
\]
\[
x = 7, -2
\]

PTS: 2  REF: 061926aii  NAT: A.REI.A.2  TOP: Solving Rationals
KEY: rational solutions

83 ANS: 
\[
2 = e^{0.0375t}
\]
\[
t \approx 18.5
\]

PTS: 4  REF: 081835aii  NAT: F.LE.A.4  TOP: Exponential Growth

84 ANS: 
\[
\frac{-1}{\sqrt{2^2 + (-1)^2}} = \frac{-1}{\sqrt{5}}
\]

PTS: 2  REF: 061832aii  NAT: F.TF.A.2  TOP: Determining Trigonometric Functions
KEY: extension to reals

85 ANS: 2
\[
x = 4y + 5
\]
\[
x - 5 = 4y
\]
\[
\frac{1}{4}x - \frac{5}{4} = y
\]

PTS: 2  REF: 061909aii  NAT: F.BF.B.4  TOP: Inverse of Functions
KEY: linear
86 ANS:
\[ 20e^{0.05t} = 30e^{0.03t} \]
\[ \frac{\frac{2}{3} e^{0.05t}}{e^{0.05t}} = \frac{e^{0.03t}}{e^{0.05t}} \]
\[ \ln \frac{2}{3} = -0.02t \]
\[ \ln \frac{2}{3} = -0.02t \ln e \]
\[ \frac{\ln \frac{2}{3}}{-0.02} = t \]
\[ 20.3 \approx t \]

PTS: 2  REF: 011829aii  NAT: A.REI.D.11  TOP: Other Systems

87 ANS:
\[ f(x) = x^2(x + 4)(x - 3); \quad g(x) = (x + 2)^2(x + 6)(x - 1) \]

PTS: 4  REF: 011836aii  NAT: A.APR.B.3  TOP: Graphing Polynomial Functions

88 ANS: 1
In vertex form, the parabola is \( y = -\frac{1}{4(2)}(x + 4)^2 + 3 \). The vertex is \((-4, 3)\) and \( p = 2 \). \( 3 + 2 = 5 \)

PTS: 2  REF: 011816aii  NAT: G.GPE.A.2  TOP: Graphing Quadratic Functions

89 ANS:
\[ \text{period} = \frac{2\pi}{0.8\pi} = 2.5. \text{ The wheel rotates once every 2.5 seconds.} \]
No, because the maximum of \( f(t) = 26 \).
90 ANS: 1

PTS: 2 REF: 081919aii NAT: S.ID.A.4 TOP: Normal Distributions
KEY: percent

91 ANS: 1

\[ p(x) = r(x) - c(x) \]
\[ -0.5x^2 + 250x - 300 = -0.3x^2 + 150x - c(x) \]
\[ c(x) = 0.2x^2 - 100x + 300 \]

PTS: 2 REF: 061813aii NAT: F.BF.A.1 TOP: Operations with Functions

92 ANS: 4

The maximum of \( p \) is 5. The minimum of \( f \) is \( \frac{-21}{4} \) \( (x = \frac{-6}{2(4)} = \frac{-3}{4}) \)

\[ f \left( \frac{3}{4} \right) = 4 \left( \frac{3}{4} \right)^2 + 6 \left( \frac{3}{4} \right) - 3 = 4 \left( \frac{9}{16} \right) - \frac{18}{4} - \frac{12}{4} = \frac{-21}{4} \]
\[ 20 \left( \frac{-21}{4} \right) = \frac{41}{4} = 10.25 \]

PTS: 2 REF: 011922aii NAT: F.IF.C.9 TOP: Comparing Functions

93 ANS: 4

\[ x(x - 2) \left( \frac{10}{x^2 - 2x} + \frac{4}{x} = \frac{5}{x - 2} \right) \text{ is extraneous.} \]
\[ 10 + 4(x - 2) = 5x \]
\[ 10 + 4x - 8 = 5x \]
\[ 2 = x \]

PTS: 2 REF: 081915aii NAT: A.REI.A.2 TOP: Solving Rationals
KEY: rational solutions
94 ANS: 4

$120 = 68 + (195 - 68)e^{-0.05t}$

$52 = 127e^{-0.05t}$

$\ln \frac{52}{127} = -0.05t$

$\ln \frac{52}{127} = -0.05t$

$\ln \frac{52}{127} = -0.05t$

$\frac{-0.05}{-0.05} = t$

$18 \approx t$

PTS: 2 REF: 081918a
NAT: F.LE.A.4 TOP: Exponential Decay

95 ANS:

$\frac{B(11) - B(8)}{11 - 8} \approx -10.1$ The average monthly high temperature decreases 10.1° each month from August to November.

PTS: 2 REF: 011930a
NAT: F.IF.B.6 TOP: Rate of Change

96 ANS:

$\frac{103}{110 + 103} = \frac{103}{213}$

PTS: 2 REF: 061825a
NAT: S.CP.A.4 TOP: Conditional Probability

97 ANS: 2

PTS: 2 REF: 011820a
NAT: S.IC.A.2 TOP: Analysis of Data

98 ANS:

$x^2 + (x - 28)^2 = 400 \quad y = 12 - 28 = -16 \quad y = 16 - 28 = -12$

$x^2 + x^2 - 56x + 784 = 400$

$2x^2 - 56x + 384 = 0$

$x^2 - 28x + 192 = 0$

$(x - 16)(x - 12) = 0$

$x = 12, 16$

PTS: 2 REF: 081831a
NAT: A.REI.C.7 TOP: Quadratic-Linear Systems

99 ANS: 2

$x = \frac{2 \pm \sqrt{(-2)^2 - 4(5)(4)}}{2(5)} = \frac{2 \pm \sqrt{-76}}{10} = \frac{2 \pm i\sqrt{19}}{10} = \frac{1}{5} \pm \frac{i\sqrt{19}}{5}$

PTS: 2 REF: 011905a
NAT: A.REI.B.4 TOP: Solving Quadratics

KEY: complex solutions | quadratic formula
100 ANS: 2
\[
n^2 \left( n^2 - 9 \right) + 4n \left( n^2 - 9 \right) - 12 \left( n^2 - 9 \right)
\]
\[
\left( n^2 + 4n - 12 \right) \left( n^2 - 9 \right)
\]
\[
(n + 6)(n - 2)(n + 3)(n - 3)
\]
PTS: 2 REF: 061911aii NAT: A.SSE.A.2 TOP: Factoring Polynomials
KEY: factoring by grouping

101 ANS: 4
\[
p(5) = 2(5)^3 - 3(5) + 5 = 240
\]
PTS: 2 REF: 011819aii NAT: A.APR.B.2 TOP: Remainder Theorem

102 ANS: 2 PTS: 2 REF: 081816aii NAT: F.IF.C.7
TOP: Graphing Logarithmic Functions
KEY: bimodalgraph

103 ANS: 2 PTS: 2 REF: 011806aii NAT: A.APR.C.4
TOP: Polynomial Identities

104 ANS: 4 PTS: 2 REF: 081803aii NAT: F.BF.A.1
TOP: Operations with Functions

105 ANS: 3 PTS: 2 REF: 061910aii NAT: F.BF.A.2
TOP: Sequences

106 ANS: 1
\[
\sqrt[4]{81x^8y^6} = 81^{\frac{1}{4}} x^{\frac{8}{4}} y^{\frac{6}{4}} = 3x^2y^\frac{3}{2}
\]
PTS: 2 REF: 012001aii NAT: N.RN.A.2 TOP: Radicals and Rational Exponents
KEY: variables

107 ANS:
\[
\left( \frac{\sqrt{2x^2}}{\sqrt[5]{x^3}} \right) = x^{\frac{2}{7}} \cdot x^\frac{3}{5} = x^{\frac{31}{35}} = \sqrt[35]{x^{31}}
\]
PTS: 2 REF: 061929aii NAT: N.RN.A.2 TOP: Radicals and Rational Exponents
KEY: variables

108 ANS: 4 PTS: 2 REF: 081817aii NAT: F.BF.B.3
TOP: Transformations with Functions
\[
\frac{x^3 + 4}{x + 2}
\]
\[
x^4 + 2x^3 + 4x - 10
\]
\[
x^3 + 4 - \frac{18}{x + 2}.
\]
No, because there is a remainder.
\[
x^4 + 2x^3
\]
\[
4x - 10
\]
\[
4x + 8
\]
\[
-18
\]

PTS: 4  REF: 011934aii  NAT: A.APR.D.6  TOP: Rational Expressions
KEY: division

110 ANS:
\[
16x^4 - 81 = \left(4x^2 + 9\right)\left(4x^2 - 9\right) = \left(4x^2 + 9\right)(2x + 3)(2x - 3).
\]
No, because \(\pm \frac{3i}{2}\) are roots.

PTS: 4  REF: 061933aii  NAT: F.IF.B.4  TOP: Graphing Polynomial Functions

111 ANS: 1
\[
9110 = 5000e^{30r}
\]
\[
\ln \frac{911}{500} = \ln e^{30r}
\]
\[
\frac{\ln 911}{30} = r
\]
\[
r \approx 0.02
\]

PTS: 2  REF: 011810aii  NAT: F.LE.A.4  TOP: Exponential Growth

112 ANS: 4
There is no \(x\)-intercept.

PTS: 2  REF: 011823aii  NAT: F.IF.C.7  TOP: Graphing Exponential Functions

113 ANS: 1
\[
\frac{N(10) - N(1)}{10 - 1} \approx -2.03, \quad \frac{N(20) - N(10)}{20 - 10} \approx -1.63, \quad \frac{N(25) - N(15)}{25 - 15} \approx -1.46, \quad \frac{N(30) - N(1)}{30 - 1} \approx -1.64
\]

PTS: 2  REF: 061807aii  NAT: F.IF.B.6  TOP: Rate of Change

114 ANS: 1
\[
84.1\% \times 750 \approx 631
\]

PTS: 2  REF: 011923aii  NAT: S.ID.A.4  TOP: Normal Distributions
KEY: predict
23 − 18 = 5, \( \bar{x} \pm 2\sigma = -3.07 - 3.13 \), Yes, a difference of 5 or more occurred three times out of a thousand, which is statistically significant.

\[
\begin{align*}
211(b)^2 &= 64 \\
&= 64 \left( \frac{8}{11} \right)^2 \\
b &= \frac{8}{11}
\end{align*}
\]

\[
PTS: 2 \quad \text{REF: 011904aii} \quad \text{NAT: F.IF.A.3} \quad \text{TOP: Sequences}
\]

KEY: explicit

\[
\begin{align*}
165 + 66 - 33 &= 198 \\
\frac{825}{825} &= 1
\end{align*}
\]

\[
PTS: 2 \quad \text{REF: 081925aii} \quad \text{NAT: S.CP.B.6} \quad \text{TOP: Conditional Probability}
\]

\[
\begin{align*}
\frac{1}{12} &= 1.025 \\
1.025^{1/12} &\approx 1.00206
\end{align*}
\]

\[
PTS: 2 \quad \text{REF: 081924aii} \quad \text{NAT: A.SSE.B.3} \quad \text{TOP: Modeling Exponential Functions}
\]

\[
\begin{align*}
\frac{1}{2} &= 0.5 \\
\frac{1}{12} &\approx 1.00206
\end{align*}
\]

\[
PTS: 2 \quad \text{REF: 061917aii} \quad \text{NAT: F.LE.B.5} \quad \text{TOP: Modeling Exponential Functions}
\]

\[
\begin{align*}
&= 0.499 \pm 2(0.049) \\
&= 0.401 - 0.597. \quad \text{Since 0.43 falls within this interval, Robin’s coin is likely not unfair.}
\end{align*}
\]

\[
PTS: 2 \quad \text{REF: 061932aii} \quad \text{NAT: S.IC.A.2} \quad \text{TOP: Analysis of Data}
\]

\[
\begin{align*}
\frac{165 + 66 - 33}{825} &= 198 \\
\frac{825}{825} &= 1
\end{align*}
\]

\[
PTS: 2 \quad \text{REF: 081925aii} \quad \text{NAT: S.CP.B.6} \quad \text{TOP: Conditional Probability}
\]

\[
\begin{align*}
\frac{1}{12} &= 0.5 \\
\frac{1}{12} &\approx 1.00206
\end{align*}
\]

\[
PTS: 2 \quad \text{REF: 081924aii} \quad \text{NAT: A.SSE.B.3} \quad \text{TOP: Modeling Exponential Functions}
\]

\[
\begin{align*}
\frac{1}{2} &= 0.5 \\
\frac{1}{12} &\approx 1.00206
\end{align*}
\]

\[
PTS: 2 \quad \text{REF: 061917aii} \quad \text{NAT: F.LE.B.5} \quad \text{TOP: Modeling Exponential Functions}
\]

\[
\begin{align*}
\frac{1}{2} &= 0.5 \\
\frac{1}{12} &\approx 1.00206
\end{align*}
\]

\[
PTS: 2 \quad \text{REF: 061906aii} \quad \text{NAT: F.LE.A.2} \quad \text{TOP: Families of Functions}
\]

\[
\begin{align*}
\frac{1}{2} &= 0.5 \\
\frac{1}{12} &\approx 1.00206
\end{align*}
\]

\[
PTS: 2 \quad \text{REF: 011831aii} \quad \text{NAT: F.IF.C.7} \quad \text{TOP: Graphing Polynomial Functions}
\]
2) linear, 3) quadratic, 4) cubic

PTS: 2  REF: 061920aii  NAT: F.LE.A.2  TOP: Families of Functions

ANS:

PTS: 2  REF: 011932aii  NAT: F.IF.C.7  TOP: Graphing Logarithmic Functions

TOP: Analysis of Data
KEY: type

ANS:

1200 \cdot 0.784 \approx 941

PTS: 2  REF: 081828aii  NAT: S.ID.A.4  TOP: Normal Distributions

KEY: predict

ANS: 1  PTS: 2  REF: 011902aii  NAT: F.IF.C.7

TOP: Graphing Logarithmic Functions

ANS: 2

PTS: 2  REF: 061817aii  NAT: S.ID.A.4  TOP: Normal Distributions

KEY: probability

ANS:

2(0.042) = 0.084 \approx 0.08  The percent of users making in-app purchases will be within 8% of 35%.

PTS: 2  REF: 081832aii  NAT: S.IC.B.4  TOP: Analysis of Data
131 ANS: 2
\[ y = \frac{1}{2}x + 8 \quad x = \frac{1}{2}y + 8 \]
\[ 2x = y + 16 \]
\[ y = 2x - 16 \]

PTS: 2 
REF: 081806aii 
NAT: F.BF.B.4 
TOP: Inverse of Functions

KEY: linear

132 ANS:
\[ \frac{9}{6} = 1.5 \quad a_1 = 6 \]
\[ a_n = 1.5 \cdot a_{n-1} \]

PTS: 2 
REF: 061931aii 
NAT: F.LE.A.2 
TOP: Sequences

KEY: recursive

133 ANS: 3
\[ x^2 + (2x)^2 = 5 \quad y = 2x = \pm 2 \]
\[ x^2 + 4x^2 = 5 \]
\[ 5x^2 = 5 \]
\[ x = \pm 1 \]

PTS: 2 
REF: 081916aii 
NAT: A.REI.C.7 
TOP: Quadratic-Linear Systems

134 ANS:
\[ -\frac{1}{2}i^3 (3i - 4) - 3i^2 = -\frac{3}{2}i^4 + 2i^3 - 3i^2 = -\frac{3}{2} - 2i + 3 = \frac{3}{2} - 2i \]

PTS: 2 
REF: 081927aii 
NAT: N.CN.A.2 
TOP: Operations with Complex Numbers

135 ANS: 1
\[ 1240(1.06)^x = 890(1.11)^x \]
\[ x \approx 7 \]

PTS: 2 
REF: 061814aii 
NAT: A.REI.D.11 
TOP: Other Systems

136 ANS: 2
\[ \frac{85}{210 + 85} \]

PTS: 2 
REF: 081818aii 
NAT: S.CP.A.1 
TOP: Venn Diagrams

137 ANS: 2
\[ 4x \cdot x^\frac{2}{3} + 2x^\frac{5}{3} = 4x^\frac{5}{3} + 2x^\frac{5}{3} = 6x^\frac{5}{3} = 6\sqrt[3]{x^5} \]

PTS: 2 
REF: 061820aii 
NAT: N.RN.A.2 
TOP: Operations with Radicals

KEY: with variables, index > 2
The period of $P$ is $\frac{2}{3}$, which means the patient’s blood pressure reaches a high every $\frac{2}{3}$ second and a low every $\frac{2}{3}$ second. The patient’s blood pressure is high because \( \frac{144}{96} \) is greater than \( \frac{120}{80} \).

\[ P(-2) = 60 \quad Q(-2) = 0 \quad (x + 2) \text{ is a factor of } Q(x) \text{ since } Q(-2) = 0. \]

\[ \frac{x^2 - 4x}{2x} = \frac{x(x - 4)}{2x} = \frac{x - 4}{2} = \frac{x}{2} - \frac{4}{2} = \frac{x - 4}{2} \]

\[ C(t) = 63000 \left(1 + \frac{0.0255}{12}\right)^{12t} \]

\[ 12t \log(1.002125) = \log \frac{100}{63} \]

\[ t \approx 18.14 \]
\[
\begin{align*}
&\frac{2x + 1}{x + 2} \left( 2x^2 + 5x + 8 \right) \\
&= \frac{2x^2 + 4x}{x + 8} \\
&\quad \frac{x + 2}{6}
\end{align*}
\]

**TOP:** Rational Expressions
**NAT:** A.APR.D.6
**REF:** 012007aii
**KEY:** division

**ANS:** 3
**PTS:** 2

**ANS:** 4
**PTS:** 2
**REF:** 061921aii
**NAT:** A.APR.B.3
**TOP:** Graphing Polynomial Functions

\[
\begin{align*}
\frac{3}{\sqrt[3]{x^3 y^5}} &= \frac{\frac{2}{3}}{x y} = \frac{\frac{8}{12}}{x y} = x \cdot \frac{-\frac{1}{12}}{y^\frac{2}{3}} \\
\frac{4}{\sqrt[4]{x^3 y^4}} &= \frac{\frac{3}{4}}{x y} = \frac{\frac{9}{12}}{x y} = x \cdot \frac{-\frac{1}{12}}{y^\frac{3}{5}}
\end{align*}
\]

**TOP:** Radicals and Rational Exponents
**NAT:** N.RN.A.2
**REF:** 011925aii
**KEY:** variables

**ANS:**
\[
\begin{align*}
a + 4b + 6c &= 23 \\
a + 2b + c &= 2 \\
8b + 3c &= 16 \\
2b + 5(4) &= 21 \\
a + 4 \left( \frac{1}{2} \right) + 6(4) &= 23 \\
a + 2b + c &= 14 \\
a + 6b + 2c &= 16 \\
8b + 20c &= 84 \\
2b &= 1 \\
a + 2 + 24 &= 23 \\
2b + 5c &= 21 \\
8b + 3c &= 16 \\
17c &= 68 \\
\frac{b}{2} &= -3 \\
c &= 4
\end{align*}
\]

**TOP:** Solving Linear Systems
**NAT:** A.REI.C.6
**REF:** 011933aii
**KEY:** three variables

**ANS:** 4

\[
S_7 = \frac{85000 - 85000(1.06)^7}{1 - 1.06} \approx 713476.20
\]

**TOP:** Series
**NAT:** A.SSE.B.4
**REF:** 061905aii
149 ANS: 2

\[
g(x) = x^3 - 2x^2 + 1
\]

PTS: 2 REF: 012021aii NAT: A.REI.D.11 TOP: Other Systems

150 ANS: 3

\[1^3 - k(1)^2 + 2(1) = 0\]

\[k = 3\]

PTS: 2 REF: 061812aii NAT: A.APR.B.2 TOP: Remainder Theorem

151 ANS: 1

\[100 \left( 0.5 \right) ^ {\frac{1}{8}} = 100e^{\frac{k}{8}}\]

\[\left( 0.5 \right) ^ {\frac{1}{8}} = e^{k}\]

\[k \approx -0.087\]

PTS: 2 REF: 061818aii NAT: A.SSE.B.3 TOP: Modeling Exponential Functions

152 ANS: 1

TOP: Unit Circle

PTS: 2 REF: 011815aii NAT: F.TF.A.2

153 ANS: 2

\[1.00643^{12} \approx 1.08\]

PTS: 2 REF: 081808aii NAT: A.SSE.B.3 TOP: Modeling Exponential Functions

154 ANS: 4

\[a_1 = 2.5 + 0.5(1) = 3\]

PTS: 2 REF: 011916aii NAT: F.BF.A.2 TOP: Sequences

155 ANS: 2

\[5x^2 - 4x + 2 = 0\]

\[
= \frac{4 \pm \sqrt{(-4)^2 - 4(5)(2)}}{2(5)} = \frac{4 \pm \sqrt{-24}}{10} = \frac{4 \pm 2i\sqrt{6}}{10} = \frac{2 \pm i\sqrt{6}}{5}
\]

PTS: 2 REF: 012020aii NAT: A.REI.B.4 TOP: Solving Quadratics

KEY: complex solutions | quadratic formula
\[
\frac{10.1 - (-2)}{2} - \frac{2.5 - (-0.1)}{2} = 6.05 - 1.3 = 4.75
\]

PTS: 2  REF: 081930aii  NAT: F.IF.C.7  TOP: Graphing Trigonometric Functions
KEY: amplitude

ANS: 3  PTS: 2  REF: 061824aii  NAT: A.CED.A.1  TOP: Modeling Rationals

ANS: 2  PTS: 2  REF: 011901aii  NAT: S.ID.A.4  TOP: Normal Distributions
KEY: mean and standard deviation

ANS: 1

\[-4(-1) - 3 = 1 8 = \frac{2\pi}{b}
\]

\[b = \frac{\pi}{4}
\]

PTS: 2  REF: 081820aii  NAT: F.IF.B.4  TOP: Graphing Trigonometric Functions
KEY: maximum/minimum

ANS: 4
The vertex is (2,2) and \( p = 3 \). 3 + 2 = 5

PTS: 2  REF: 081823aii  NAT: G.GPE.A.2  TOP: Graphing Quadratic Functions

ANS:

PTS: 2  REF: 011926aii  NAT: F.IF.C.7  TOP: Graphing Polynomial Functions

ANS: 3  PTS: 2  REF: 012003aii  NAT: A.APR.C.4  TOP: Polynomial Identities

ANS: 3  PTS: 2  REF: 081909aii  NAT: F.BF.A.2  TOP: Sequences  KEY: recursive

ANS: 4

\[\frac{13}{13 + 11} = \frac{13}{24}
\]

PTS: 2  REF: 012011aii  NAT: S.CP.A.4  TOP: Conditional Probability

ANS: 4  (1) and (3) are not recursive

PTS: 2  REF: 012013aii  NAT: F.LE.A.2  TOP: Sequences  KEY: recursive

ANS: 4  PTS: 2  REF: 081912aii  NAT: F.IF.C.7  TOP: Graphing Trigonometric Functions  KEY: mixed
167 ANS:

\[ y = \frac{1}{4(2)} (x - 4)^2 - 3 \]

\[ y = \frac{-1 + -5}{2} = -3. \] The vertex is \((4, -3)\) and \(p = 2\).

PTS: 4 REF: 061935aii NAT: G.GPE.A.2 TOP: Graphing Quadratic Functions

168 ANS: 3

\[ 440 \times 2.3\% \approx 10 \]

PTS: 2 KEY: predict

REF: 011807aii NAT: S.ID.A.4 TOP: Normal Distributions

169 ANS: 2

\[ f(x) = f(-x) \]

\[ x^2 - 4 = (-x)^2 - 4 \]

\[ x^2 - 4 = x^2 - 4 \]

PTS: 2 REF: 061806aii NAT: F.BF.B.3 TOP: Even and Odd Functions

170 ANS: 3

\[ y = x^3 - 2 \]

\[ x = y^3 - 2 \]

\[ x + 2 = y^3 \]

\[ \frac{3}{\sqrt{x + 2}} = y \]

PTS: 2 KEY: other

REF: 061815aii NAT: F.BF.B.4 TOP: Inverse of Functions

171 ANS: 1

\[ 3x + 1 \]

\[ \frac{3x - 1}{9x^2 + 0x - 2} \]

\[ 9x^2 + 3x \]

\[ -3x - 2 \]

\[ -3x - 1 \]

\[ -1 \]

PTS: 2 KEY: division

REF: 081910aii NAT: A.APR.D.6 TOP: Rational Expressions
\[ P(A + B) = P(A) \cdot P(B|A) = 0.8 \cdot 0.85 = 0.68 \]

PTS: 2  REF: 011928aii  NAT: S.CP.A.3  TOP: Conditional Probability

173 ANS: 4

\[
\log_2 t = \frac{\log \sqrt{10}}{\log 2} = \frac{\log 2 \sqrt{10}}{\log 2}, \quad 1) \log_2 \sqrt{10} = \frac{1}{2} \log_2 10, \quad 3) \log_4 10 = \frac{\log_2 10}{\log_2 4} = \frac{1}{2} \log_2 10
\]

\[ t = \frac{\log \sqrt{10}}{\log 2} \]

PTS: 2  REF: 012009aii  NAT: F.LE.A.4  TOP: Exponential Equations
KEY: without common base

174 ANS: 2  PTS: 2  REF: 081908aii  NAT: F.IF.B.4
TOP: Graphing Polynomial Functions

175 ANS: 3  PTS: 2  REF: 012005aii  NAT: F.IF.B.4
TOP: Graphing Polynomial Functions

176 ANS:
\[
j(-1) = 2(-1)^4 - (-1)^3 - 35(-1)^2 + 16(-1) + 48 = 2 + 1 - 35 - 16 + 48 = 0; \quad x + 1 \text{ is a factor of } j(x);
\]
\[ 2x^3 - 3x^2 - 32x + 48 = 0 \]
\[ x^2(2x - 3) - 16(2x - 3) = 0 \]
\[ (x^2 - 16)(2x - 3) = 0 \]
\[ x = \pm 4, \quad \frac{3}{2} \]

PTS: 4  REF: 081834aii  NAT: A.APR.B.2  TOP: Remainder Theorem

177 ANS:

\[ y = 2 \sin 4x \]

PTS: 4  REF: 081934aii  NAT: F.IF.C.7  TOP: Graphing Trigonometric Functions
KEY: graph
178 ANS: 3

![Graph of a polynomial function]

PTS: 2 REF: 011817aii NAT: F.IF.B.4 TOP: Graphing Polynomial Functions

179 ANS:

\[3\sqrt{x} - 2x = -5 \quad \text{1 is extraneous.}\]

\[3\sqrt{x} = 2x - 5\]

\[9x = 4x^2 - 20x + 25\]

\[4x^2 - 29x + 25 = 0\]

\[(4x - 25)(x - 1) = 0\]

\[x = \frac{25}{4}, 1\]

PTS: 4 REF: 011936aii NAT: A.REI.A.2 TOP: Solving Radicals

KEY: extraneous solutions

180 ANS:

\[M = \frac{(152500 - 15250) \left( \frac{0.036}{12} \right) \left( 1 + \frac{0.36}{12} \right)^{360}}{\left( 1 + \frac{0.036}{12} \right)^{360} - 1} \approx 624\]

PTS: 2 REF: 061831aii NAT: A.SSE.B.4 TOP: Series

181 ANS:

\[(a + b)^3 = a^3 + b^3 \quad \text{No. Erin’s shortcut only works if } a = 0, b = 0 \text{ or } a = -b.\]

\[a^3 + 3a^2b + 3ab^2 + b^3 = a^3 + b^3\]

\[3ab^2 + 3a^2b = 0\]

\[3ab(b + a) = 0\]

\[a = 0, b = 0, a = -b\]

PTS: 2 REF: 011927aii NAT: A.APR.C.4 TOP: Polynomial Identities
\[
\frac{2}{x} = \frac{4x}{x + 3}
\]

\[2x + 6 = 4x^2\]

\[4x^2 - 2x - 6 = 0\]

\[2(2x^2 - x - 3) = 0\]

\[(2x - 3)(x + 1) = 0\]

\[x = \frac{3}{2}, -1\]

183 ANS:

\[
\frac{47}{108} = \frac{1}{4} + \frac{116}{459} = P(M \text{ and } J); \text{ No, because } \frac{31}{459} \neq \frac{1}{4} \cdot \frac{116}{459}
\]

\[P(M \text{ and } J) = \frac{31}{459}\]

184 ANS:

PTS: 2  REF: 081932aii  NAT: A.REI.D.11  TOP: Other Systems
B = 1.69\sqrt{30 + 4.45} – 3.49 \approx 6, which is a steady breeze.

15 = 1.69\sqrt{s + 4.45} – 3.49

18.49 = 1.69\sqrt{s + 4.45}

\frac{18.49}{1.69} = \sqrt{s + 4.45}

\left(\frac{18.49}{1.69}\right)^2 = s + 4.45

s = \left(\frac{18.49}{1.69}\right)^2 - 4.45

s \approx 115

9.5 = 1.69\sqrt{s + 4.45} – 3.49

10.49 = 1.69\sqrt{s + 4.45} - 3.49

12.99 = 1.69\sqrt{s + 4.45}

13.98 = 1.69\sqrt{s + 4.45}

\frac{12.99}{1.69} = \sqrt{s + 4.45}

\left(\frac{13.98}{1.69}\right)^2 = s + 4.45

s = \left(\frac{13.98}{1.69}\right)^2 - 4.45

s \approx 55

s \approx 64

\text{ANS:} 3

\frac{x^2(x + 2) - 9(x + 2)}{x(x^2 - x - 6)} = \frac{(x^2 - 9)(x + 2)}{x(x - 3)(x + 2)} = \frac{(x + 3)(x - 3)}{x(x - 3)} = \frac{x + 3}{x}

\text{PTS: 2} \quad \text{REF: 061803a1i} \quad \text{NAT: A.APR.D.6} \quad \text{TOP: Rational Expressions}

\text{KEY: factoring}

\text{ANS: 2}

\text{PTS: 2} \quad \text{REF: 081920a1i} \quad \text{NAT: A.REI.D.11} \quad \text{TOP: Other Systems}
\( A(t) = 318000(1.07)^t \)
\[ 318000(1.07)^t = 1000000 \]

The graph of \( A(t) \) nearly intersects the point \((17,1000000)\).

\[ t \log 1.07 = \log \frac{1000}{318} \]
\[ t = \frac{\log 1000}{\log 1.07} \]
\[ t \approx 17 \]

\( P(x) = R(x) - C(x) = -330x^3 + 9000x^2 - 67000x + 167000 \)

Least profitable at year 5 because there is a minimum in \( P(x) \). Most profitable at year 13 because there is a maximum in \( P(x) \).
\[-6(x + 3) \left( \frac{-3}{x + 3} - \frac{x}{6} + 1 = 0 \right)\]

\[18 + x(x + 3) - 6(x + 3) = 0\]
\[18 + x^2 + 3x - 6x - 18 = 0\]
\[x^2 - 3x = 0\]
\[x(x - 3) = 0\]
\[x = 0, 3\]

PTS: 2  REF: 081829aii  NAT: A.REI.A.2  TOP: Solving Rationals
KEY: rational solutions

ANS: 3  PTS: 2  REF: 011917aii  NAT: F.BF.B.4
TOP: Inverse of Functions
KEY: other

138.905 ± 2 ⋅ 7.95 = 123 – 155. No, since 125 (50% of 250) falls within the 95% interval.

PTS: 4  REF: 011835aii  NAT: S.IC.A.2  TOP: Analysis of Data

\[P(B) \cdot P(A|B) = P(A \text{ and } B)\]
\[P(B) \cdot 0.8 = 0.2\]
\[P(B) = 0.25\]

PTS: 2  REF: 081913aii  NAT: S.CP.A.3  TOP: Conditional Probability

\[x = \frac{y}{y+2}\]
\[xy + 2x = y\]
\[xy - y = -2x\]
\[y(x - 1) = -2x\]
\[y = \frac{-2x}{x - 1}\]

PTS: 2  REF: 081924aii  NAT: F.BF.B.4  TOP: Inverse of Functions
KEY: other

\[\sqrt{1 - \left( -\frac{3}{4} \right)^2} = \sqrt{16/16 - 9/16} = \sqrt{7/16} = \frac{\sqrt{7}}{4}\]

PTS: 2  REF: 081905aii  NAT: F.TF.C.8  TOP: Determining Trigonometric Functions

ANS: 1  PTS: 2  REF: 061904aii  NAT: F.IF.B.6  TOP: Rate of Change
198  ANS: 4  PTS: 2  REF: 061907aii  NAT: A.APR.B.2
TOP: Remainder Theorem

199  ANS: 4  PTS: 2  REF: 012014aii  NAT: S.IC.B.5
TOP: Analysis of Data

200  ANS: 1
\[(2x - i)^2 - (2x - i)(2x + 3i)\]
\[(2x - i)[(2x - i) - (2x + 3i)]\]
\[(2x - i)(-4i)\]
\[-8xi + 4i^2\]
\[-8xi - 4\]

PTS: 2  REF: 011911aii  NAT: N.CN.A.2  TOP: Operations with Complex Numbers

201  ANS:
\[\frac{13.9 - 9.4}{4 - 1} = 1.5\]  The average rate of change in the number of hours of daylight from January 1-April 1 is 1.5.

PTS: 2  REF: 061925aii  NAT: F.IF.B.6  TOP: Rate of Change

202  ANS: 1
The cosine function has been translated +3. Since the maximum is 5 and the minimum is 1, the amplitude is 2.
\[\frac{\pi}{3} = \frac{2\pi}{b}\]
\[b = 6\]

PTS: 2  REF: 011913aii  NAT: F.TF.B.5  TOP: Modeling Trigonometric Functions

203  ANS: 3
\[-3 + 5i - \left(4 + 24i - 2i - 12i^2\right) = -3 + 5i - (16 + 22i) = -19 - 17i\]

PTS: 2  REF: 081815aii  NAT: N.CN.A.2  TOP: Operations with Complex Numbers

204  ANS: 4

PTS: 2  REF: 011924aii  NAT: A.REI.D.11  TOP: Other Systems
205 ANS: 
\[
\left(x^2 - 6\right)\left(x^2 + 2\right)
\]
PTS: 2 
REF: 081825a
NAT: A.SSE.A.2 
TOP: Factoring Polynomials
KEY: higher power

206 ANS: 2 
PTS: 2 
REF: 011910a
NAT: S.IC.B.3 
TOP: Analysis of Data
KEY: bias

207 ANS: 
\[N(t) = 950e^{0.0475t}\] The base is \(e\) because growth is continuous. \(\frac{36}{24}\) \(\approx 1020\)

PTS: 4 
REF: 081933a
NAT: F.LE.A.2 
TOP: Modeling Exponential Functions

208 ANS: Self selection is a cause of bias because people with more free time are more likely to respond.

PTS: 2 
REF: 061828a
NAT: S.IC.B.3 
TOP: Analysis of Data
KEY: bias

209 ANS: 4 
PTS: 2 
REF: 012016a
NAT: F.IF.B.4 
TOP: Graphing Trigonometric Functions
KEY: increasing/decreasing

210 ANS: 4 
\[a = \frac{14 - 4}{2} = 5, \quad d = \frac{14 + 4}{2} = 9\]

PTS: 2 
REF: 061810a
NAT: F.TF.B.5 
TOP: Modeling Trigonometric Functions

211 ANS: 
\[P(16) = \log(16 - 4) \approx 1.1, \quad 14000\]

PTS: 6 
REF: 061837a
NAT: A.REI.D.11 
TOP: Other Systems

212 ANS: 1 
The time of the next high tide will be the midpoint of consecutive low tides.

PTS: 2 
REF: 011907a
NAT: F.IF.C.7 
TOP: Graphing Trigonometric Functions
KEY: mixed

213 ANS: 
\[S_{10} = \frac{15 - 15(1.03)^{10}}{1 - 1.03} \approx 171.958\]

PTS: 2 
REF: 011929a
NAT: A.SSE.B.4 
TOP: Series
\[ x = \frac{-5 \pm \sqrt{5^2 + 4(2)(8)}}{2(2)} = \frac{-5 \pm i\sqrt{39}}{4} \]

PTS: 2  
REF: 061827aii  
NAT: A.REI.B.4  
TOP: Solving Quadratics  
KEY: complex solutions | quadratic formula

ANS: 3  
PTS: 2  
REF: 012002aii  
NAT: F.BF.A.1  
TOP: Operations with Functions

ANS: 2

PTS: 2  
REF: 081830aii  
NAT: F.IF.C.7  
TOP: Graphing Trigonometric Functions  
KEY: graph

ANS: 2

\[ P = \frac{2\pi}{\frac{\pi}{45}} = 90 \]

PTS: 2  
REF: 081822aii  
NAT: F.IF.C.7  
TOP: Graphing Trigonometric Functions  
KEY: period

ANS: \[
\frac{p(8) - p(4)}{8 - 4} \approx 48.78
\]

PTS: 2  
REF: 081827aii  
NAT: F.IF.B.6  
TOP: Rate of Change

ANS: 4  
PTS: 2  
REF: 011805aii  
NAT: F.LE.B.5  
TOP: Modeling Exponential Functions

ANS: 1

\[ x^2 + 2x + 1 = (x + 1)^2 \]

PTS: 2  
REF: 011919aii  
NAT: A.APR.B.3  
TOP: Graphing Polynomial Functions
221 ANS: 2
\[ x = -6(y - 2) \]
\[ \frac{x}{6} = y - 2 \]
\[ \frac{x}{6} + 2 = y \]

PTS: 2    REF: 011821aii   NAT: F.BF.B.4   TOP: Inverse of Functions
KEY: linear

222 ANS: 3

PTS: 2    REF: 081922aii   NAT: F.IF.B.6   TOP: Rate of Change

223 ANS: 2
TOP: Graphing Exponential Functions

224 ANS:
\[
\frac{2a^2 + 5a + 2}{3a - 2} = \frac{6a^3 + 11a^2 - 4a - 9}{6a^3 - 4a^2} - \frac{2a^2 + 5a + 2}{3a - 2}
\]
\[
= \frac{15a^2 - 4a}{6a - 9}
\]
\[
= \frac{15a^2 - 10a}{6a - 4}
\]
\[
= \frac{6a - 9}{6a - 4}
\]
\[
= \frac{-5}{6a - 4}
\]

PTS: 2    REF: 061829aii   NAT: A.APR.D.6   TOP: Rational Expressions
KEY: division

225 ANS: 1
\[(x + 7)(x - 1) = x^2 + 6x - 7 = x^2 + 6x + 9 - 7 - 9 = (x + 3)^2 - 16\]

PTS: 2    REF: 061808aii   NAT: A.APR.C.4   TOP: Polynomial Identities
\[ x^2 - 6x = -17 \] The solution is imaginary because the parabola and line do not intersect.

\[
x^2 - 6x + 9 = -17 + 9
\]

\[
(x - 3)^2 = -8
\]

\[
x - 3 = \pm 2i\sqrt{2}
\]

\[
x = 3 \pm 2i\sqrt{2}
\]
233  ANS: 2
\[
\begin{align*}
2x + 2y - 2z &= 12 \\
5y - 4z &= 31 \\
5y - 2(-4) &= 23 \\
x + 3 - (-4) &= 6 \\
-x + 4y - z &= 17 \\
2x - 3y + 2z &= -19 \\
5y - 2z &= 23 \\
y &= 3 \\
-2z &= 8 \\
z &= -4
\end{align*}
\]

234  ANS: 2
\[
x^2 = 3x + 40. \ x = -5 \text{ is an extraneous solution.}
\]
\[
x^2 - 3x - 40 = 0
\]
\[
(x - 8)(x + 5) = 0
\]
\[
x = 8, -5
\]

235  ANS: 3  PTS: 2
\[
\text{Analysis of Data}  \quad \text{KEY: type}
\]

236  ANS: 2  PTS: 2
\[
\text{Graphing Polynomial Functions}  \quad \text{KEY: bimodalgraph}
\]

237  ANS: 
\[
\tan \theta = \frac{\sin \theta}{\cos \theta} = \frac{-7/25}{-24/25} = \frac{24}{25}
\]

238  ANS: 4
\[
\frac{n}{m} = \frac{\sqrt[5]{a^6}}{a} = \frac{a^{\frac{5}{2}}}{a} = a^{\frac{3}{2}} = \sqrt[2]{a^3}
\]

239  ANS: 4
\[
\sqrt[3]{3x^2y} \cdot \sqrt[3]{7x^3y^2} = 3^{\frac{1}{3}}xy^{\frac{1}{2}} \cdot 7^{\frac{2}{3}}xy^{\frac{2}{3}} = 3^{\frac{2}{3}}x^{\frac{7}{3}}y^6
\]

KEY: three variables

KEY: extraneous solutions

KEY: type

KEY: bimodalgraph

KEY: variables

KEY: with variables, index > 2
\[0.48 \cdot 0.25 = 0.12\]

PTS: 1 REF: 061811aii NAT: S.CP.A.2 TOP: Probability of Compound Events

KEY: probability

241 ANS:

\[a_1 = 3 \quad a_2 = 7 \quad a_3 = 15 \quad a_4 = 31; \text{ No, because there is no common ratio: } \frac{7}{3} \neq \frac{15}{7}\]

PTS: 2 REF: 061830aii NAT: F.IF.A.3 TOP: Sequences

KEY: recursive

242 ANS:

\[3 \cdot x^3 + x^2 + 3xy + y = x^2(3x + 1) + y(3x + 1) = \left(x^2 + y\right)(3x + 1)\]

PTS: 2 REF: 061826aii NAT: F.IF.C.7 TOP: Solving Polynomial Equations

KEY: factoring by grouping
\[ \sqrt{x - 5} = -x + 7 \quad \sqrt{x - 5} = -9 + 7 = -2 \text{ is extraneous.} \]

\[ x - 5 = x^2 - 14x + 49 \]
\[ 0 = x^2 - 15x + 54 \]
\[ 0 = (x - 6)(x - 9) \]
\[ x = 6, 9 \]
Algebra II Regents at Random Worksheets
Answer Section

249 ANS: 3

PTS: 2  REF: 081604aii  NAT: S.ID.A.4  TOP: Normal Distributions
KEY: probability

250 ANS: 

PTS: 2  REF: 061628aii  NAT: F.IF.C.7  TOP: Graphing Trigonometric Functions
KEY: graph

251 ANS: 
\[
\frac{8}{3} \frac{x}{4} = x^y \\
\frac{4}{3} \sqrt[4]{x} = x^y \\
\frac{4}{3} = y
\]

PTS: 2  REF: spr1505aii  NAT: N.RN.A.2  TOP: Radicals and Rational Exponents
KEY: numbers

252 ANS: 2

\[
ME = \left( z \sqrt{\frac{p(1-p)}{n}} \right) = \left( 1.96 \sqrt{\frac{(0.55)(0.45)}{900}} \right) \approx 0.03 \text{ or } \frac{1}{\sqrt{900}} \approx 0.03
\]

PTS: 2  REF: 081612aii  NAT: S.IC.B.4  TOP: Analysis of Data
253 ANS:

\[ a_n = 100(0.8)^{n-1} \quad S_{20} = \frac{100 - 100(0.8)^{20}}{1 - 0.8} \approx 494 \]  
No, because 494 > 40 \times 12.

PTS: 4  REF: 012033aii  NAT: A.SSE.B.4  TOP: Series

254 ANS: 4  PTS: 2  REF: 061706aii  NAT: F.IF.B.4  TOP: Graphing Trigonometric Functions

255 ANS: 2

\[ h(x) \] does not have a y-intercept.

PTS: 2  REF: 011719aii  NAT: F.IF.C.9  TOP: Comparing Functions

256 ANS: 2

\[
\begin{align*}
2x^2 - 3x + 7 \\
(2x + 3)(4x^3 + 0x^2 + 5x + 10)
\end{align*}
\]

\[
\begin{align*}
4x^3 + 6x^2 \\
- 6x^2 + 5x \\
- 6x^2 - 9x \\
14x + 10 \\
14x + 21 \\
- 11
\end{align*}
\]

PTS: 2  REF: 061614aii  NAT: A.APR.D.6  TOP: Rational Expressions

KEY: division

257 ANS: 2

\[
\left( \frac{5}{3} \right)^{\frac{1}{2}} = \frac{5}{\sqrt{3}}
\]

PTS: 2  REF: 011707aii  NAT: N.RN.A.2  TOP: Radicals and Rational Exponents

KEY: division

258 ANS: 1

(2) is not recursive

PTS: 2  REF: 081608aii  NAT: F.LE.A.2  TOP: Sequences

KEY: recursive

259 ANS: 3

PTS: 2  REF: 081724aii  NAT: F.BF.A.2  TOP: Sequences
\[
\frac{x^3 + 9}{x^3 + 8} = \frac{x^3 + 8 + 1}{x^3 + 8} = \frac{x^3 + 9}{x^3 + 8}
\]

PTS: 2  REF: 061631aii  NAT: A.APR.C.4  TOP: Polynomial Identities

261 ANS: 3  PTS: 2  REF: 061710aii  NAT: S.IC.A.2  TOP: Analysis of Data

262 ANS: 4
\[
x(x + 7) \left[ \frac{3x + 25}{x + 7} - 5 = \frac{3}{x} \right]
\]
\[
x(3x + 25) - 5x(x + 7) = 3(x + 7)
\]
\[
3x^2 + 25x - 5x^2 - 35x = 3x + 21
\]
\[
2x^2 + 13x + 21 = 0
\]
\[
(2x + 7)(x + 3) = 0
\]
\[
x = -\frac{7}{2}, -3
\]

PTS: 2  REF: fall1501aii  NAT: A.REI.A.2  TOP: Solving Rationals

KEY: rational solutions

263 ANS: 3

Since \(x + 4\) is a factor of \(p(x)\), there is no remainder.

PTS: 2  REF: 081621aii  NAT: A.APR.B.2  TOP: Remainder Theorem

264 ANS: 4  PTS: 2  REF: 081622aii  NAT: F.BF.A.1  TOP: Modeling Exponential Functions
\[0 = x^2(x + 1) - 4(x + 1)\]
\[0 = (x^2 - 4)(x + 1)\]
\[0 = (x + 2)(x - 2)(x + 1)\]
\[x = -2, -1, 2\]
\[ A(t) = 800e^{-0.347t} \]
\[ B(t) = 400e^{-0.231t} \]
\[ 800e^{-0.347t} = 400e^{-0.231t} \quad 0.15 = e^{-0.347t} \]
\[ \ln 2e^{-0.347t} = \ln e^{-0.231t} \quad \ln 0.15 = \ln e^{-0.347t} \]
\[ \ln 2 + \ln e^{-0.347t} = \ln e^{-0.231t} \quad \ln 0.15 = -0.347t \cdot \ln e \]
\[ \ln 2 - 0.347t = -0.231t \]
\[ \ln 2 = 0.116t \\ 6 \approx t \]

PTS: 6  REF: 061637a1i  NAT: A.REI.D.11  TOP: Other Systems

ANS:
Randomly assign participants to two groups. One group uses the toothpaste with ingredient X and the other group uses the toothpaste without ingredient X.

PTS: 2  REF: 061626aii  NAT: S.IC.B.3  TOP: Analysis of Data

KEY: type

ANS: 1
The probability of rain equals the probability of rain, given that Sean pitches.

PTS: 2  REF: 061611aii  NAT: S.CP.A.3  TOP: Conditional Probability

\[ P(W \mid D) = \frac{P(W \cap D)}{P(D)} = \frac{.4}{.5} = .8 \]

PTS: 2  REF: 081726aii  NAT: S.CP.B.6  TOP: Conditional Probability
The expression is of the form \( y^2 - 5y - 6 \) or \((y - 6)(y + 1)\). Let \( y = 4x^2 + 5x \):

\[
\left(4x^2 + 5x - 6\right)
\left(4x^2 + 5x + 1\right)
\]

\((4x - 3)(x + 2)(4x + 1)(x + 1)\)

\[\text{ANS: } \text{PTS: 2} \quad \text{REF: fall1512aii} \quad \text{NAT: A.SSE.A.2} \quad \text{TOP: Factoring Polynomials} \quad \text{KEY: a>1}\]

\[\text{ANS: } 3 \quad \text{PTS: 2} \quad \text{REF: 061720aii} \quad \text{NAT: F.LE.A.2} \quad \text{TOP: Sequences} \quad \text{KEY: explicit}\]

\[0.506 \pm 2 \cdot 0.078 = 0.35 - 0.66. \text{ The 32.5\% value falls below the 95\% confidence level.}\]

\[\text{ANS: } \text{PTS: 4} \quad \text{REF: 061736aii} \quad \text{NAT: S.IC.B.5} \quad \text{TOP: Analysis of Data}\]

\[\text{ANS: } a_1 = 4 \quad a_8 = 639 \quad a_n = 2a_{n-1} + 1 \]

\[\text{ANS: } \text{PTS: 2} \quad \text{REF: 081729aii} \quad \text{NAT: F.LE.A.2} \quad \text{TOP: Sequences} \quad \text{KEY: recursive}\]

Amplitude, because the height of the graph shows the volume of the air.

\[\text{ANS: } \text{PTS: 2} \quad \text{REF: 081625aii} \quad \text{NAT: F.IF.C.7} \quad \text{TOP: Graphing Trigonometric Functions} \quad \text{KEY: mixed}\]

\[\text{ANS: } 3 \quad \text{PTS: 2} \quad \text{REF: 081617aii} \quad \text{NAT: A.REI.A.2} \quad \text{TOP: Solving Rationals} \quad \text{KEY: rational solutions}\]

\[f(x) = -f(x), \text{ so } f(x) \text{ is odd. } g(-x) \neq g(x), \text{ so } g(x) \text{ is not even. } g(-x) \neq -g(x), \text{ so } g(x) \text{ is not odd. } h(-x) = h(x), \text{ so } \]

\[\text{h(x) is even.}\]

\[\text{ANS: } 3 \quad \text{PTS: 2} \quad \text{REF: fall1502aii} \quad \text{NAT: F.BF.B.3} \quad \text{TOP: Even and Odd Functions}\]
The vertex of the parabola is (0,0). The distance, \( p \), between the vertex and the focus or the vertex and the directrix is 1. 

\[
y = -\frac{1}{4p} (x-h)^2 + k
\]

\[
y = -\frac{1}{4(1)} (x-0)^2 + 0
\]

\[
y = -\frac{1}{4} x^2
\]

\[
y = -\frac{1}{4} x^2
\]

\[
\frac{f(7) - f(-7)}{7 - (-7)} = \frac{2^{-0.25(7)} \cdot \sin \left( \frac{\pi}{2} (7) \right) - 2^{-0.25(-7)} \cdot \sin \left( \frac{\pi}{2} (-7) \right)}{14} \approx -0.26
\]

As the range is [4,10], the midline is \( y = \frac{4+10}{2} = 7 \).
Yes. The margin of error from this simulation indicates that 95% of the observations fall within ± 0.12 of the simulated proportion, 0.25. The margin of error can be estimated by multiplying the standard deviation, shown to be 0.06 in the dotplot, by 2, or applying the estimated standard error formula, \( \sqrt{\frac{p(1-p)}{n}} \) or \( \sqrt{\frac{(0.25)(0.75)}{50}} \) and multiplying by 2. The interval 0.25 ± 0.12 includes plausible values for the true proportion of people who prefer Stephen’s new product. The company has evidence that the population proportion could be at least 25%. As seen in the dotplot, it can be expected to obtain a sample proportion of 0.18 (9 out of 50) or less several times, even when the population proportion is 0.25, due to sampling variability. Given this information, the results of the survey do not provide enough evidence to suggest that the true proportion is not at least 0.25, so the development of the product should continue at this time.

Using a 95% level of confidence, \( x \pm 2 \) standard deviations sets the usual wait time as 150-302 seconds. 360 seconds is unusual.

\[ x^2(4x - 1) + 4(4x - 1) = (x^2 + 4)(4x - 1) \]

\[ (1 - i)(1 - i)(1 - i) = (1 - 2i + i^2)(1 - i) = -2i(1 - i) = -2i + 2i^2 = -2 - 2i \]

\[ x = \frac{y + 1}{y - 2} \]
\[ xy - 2x = y + 1 \]
\[ xy - y = 2x + 1 \]
\[ y(x - 1) = 2x + 1 \]
\[ y = \frac{2x + 1}{x - 1} \]
290 ANS:
\[ S_n = \frac{33000 - 33000(1.04)^n}{1 - 1.04} \quad S_{15} = \frac{33000 - 33000(1.04)^{15}}{1 - 1.04} \approx 660778.39 \]

PTS: 4 REF: 061634aii NAT: A.SSE.B.4 TOP: Series

291 ANS: 1
\[ x^2 + 2x - 8 = 0 \]
\[ (x + 4)(x - 2) = 0 \]
\[ x = -4, 2 \]

PTS: 2 REF: 081701aii NAT: A.APR.D.6 TOP: Undefined Rationals

292 ANS: 4
\[ m^5 + m^3 - 6m = m(m^4 + m^2 - 6) = m(m^2 + 3)(m^2 - 2) \]

PTS: 2 REF: 011703aii NAT: A.SSE.A.2 TOP: Factoring Polynomials KEY: higher power

293 ANS: 2
\[ x(30 - 0.01x) - (0.15x^3 + 0.01x^2 + 2x + 120) = 30x - 0.01x^2 - 0.15x^3 - 0.01x^2 - 2x - 120 \]
\[ = -0.15x^3 - 0.02x^2 + 28x - 120 \]

PTS: 2 REF: 061709aii NAT: F.BF.A.1 TOP: Operations with Functions TOP: Modeling Trigonometric Functions

294 ANS: 1 PTS: 2 REF: 061708aii NAT: F.TF.B.5 TOP: Modeling Trigonometric Functions

295 ANS:
period is \( \frac{2}{3} \). The wheel rotates once every \( \frac{2}{3} \) second.

PTS: 2 REF: 061728aii NAT: F.IF.C.7 TOP: Graphing Trigonometric Functions KEY: period

296 ANS: 3 PTS: 2 REF: 061607aii NAT: S.IC.A.2 TOP: Analysis of Data

297 ANS:
\[ \csc \theta = \frac{1}{\sin \theta}, \text{ and } \sin \theta \text{ on a unit circle represents the } y \text{ value of a point on the unit circle. Since } y = \sin \theta, \csc \theta = \frac{1}{y}. \]

PTS: 2 REF: 011727aii NAT: F.TF.A.2 TOP: Reciprocal Trigonometric Relationships
298  ANS: 4

PTS: 2  REF: 061622a1i  NAT: A.REI.D.11  TOP: Other Systems

299  ANS: 2  PTS: 2  REF: 011709a1i  NAT: S.IC.B.5
TOP: Analysis of Data

300  ANS: 1

PTS: 2  REF: 061617a1i  NAT: F.TF.A.2  TOP: Determining Trigonometric Functions
KEY: extension to reals

301  ANS: 2

\[
x^2 + 0x + 1 \\
\overline{x + 2} \]
\[
x^3 + 2x^2 + x + 6
\]

\[
x + 2
\]
\[
x^3 + 2x^2
\]
\[
0x^2 + x
\]
\[
0x^2 + 0x
\]
\[
x + 6
\]
\[
x + 2
\]
\[
4
\]

PTS: 2  REF: 081611a1i  NAT: A.APR.D.6  TOP: Rational Expressions
KEY: division
302 ANS:

\[(4 - 3i)(5 + 2yi - 5 + 2yi)\]

\[(4 - 3i)(4yi)\]

\[16yi - 12yi^2\]

\[12y + 16yi\]

PTS: 2 REF: spr1506aii NAT: N.CN.A.2 TOP: Operations with Complex Numbers

303 ANS: 1

\[
\begin{array}{cccc}
3 & 1 & 0 & -4 \\
1 & 2 & 4 & 0 \\
1 & 2 & 0 & -4 \\
0 & 2 & 4 & 0
\end{array}
\]

Since there is no remainder when the quartic is divided by \(x - 2\), this binomial is a factor.

PTS: 2 REF: 061711aii NAT: A.APR.B.2 TOP: Remainder Theorem

304 ANS: 4

The scenario represents a decreasing geometric sequence with a common ratio of 0.80.

PTS: 2 REF: 061610aii NAT: F.BF.A.2 TOP: Sequences

305 ANS: 1

A reference triangle can be sketched using the coordinates \((-4,3)\) in the second quadrant to find the value of \(\sin \theta\).

PTS: 2 REF: spr1503aii NAT: F.TF.A.2 TOP: Determining Trigonometric Functions

KEY: extension to reals

306 ANS:

\[M = 172600 \cdot \frac{0.00305(1 + 0.00305)^{12 \cdot 15}}{(1 + 0.00305)^{12 \cdot 15} - 1} \approx 1247\]

\[1100 = (172600 - x) \cdot \frac{0.00305(1 + 0.00305)^{12 \cdot 15}}{(1 + 0.00305)^{12 \cdot 15} - 1}\]

\[1100 \approx (172600 - x) \cdot (0.007228)\]

\[152193 \approx 172600 - x\]

\[20407 \approx x\]

PTS: 4 REF: 061734aii NAT: A.SSE.B.4 TOP: Series
307 ANS: 2

PTS: 2 REF: 011716aii NAT: A.REI.D.11 TOP: Other Systems

308 ANS: 4

\[k^4 - 4k^2 + 8k^3 - 32k + 12k^2 - 48\]
\[k^2(k^2 - 4) + 8k(k^2 - 4) + 12(k^2 - 4)\]
\[(k^2 - 4)(k^2 + 8k + 12)\]
\[(k + 2)(k - 2)(k + 6)(k + 2)\]

PTS: 2 REF: fall1505aii NAT: A.SSE.A.2 TOP: Factoring Polynomials
KEY: factoring by grouping

309 ANS: 2

\[\frac{212}{1334} \approx 0.16 \quad ME = \left(z \sqrt{\frac{p(1-p)}{n}}\right) = \left(1.96 \sqrt{\frac{(0.16)(0.84)}{1334}}\right) \approx 0.02 \text{ or } \frac{1}{\sqrt{1334}} \approx 0.027\]

PTS: 2 REF: 081716aii NAT: S.IC.B.4 TOP: Analysis of Data

310 ANS: 3

\[H(t)\] is at a minimum at \(70(-1) + 80 = 10\)

PTS: 2 REF: 061613aii NAT: F.IF.B.4 TOP: Graphing Trigonometric Functions
KEY: maximum/minimum

311 ANS:

As \(x \to -3, y \to -\infty\). As \(x \to \infty, y \to \infty\).

PTS: 4 REF: 061735aii NAT: F.IF.C.7 TOP: Graphing Logarithmic Functions
312 ANS:

PTS: 2  REF: 081732aii  NAT: F.IF.C.7  TOP: Graphing Polynomial Functions

313 ANS:

Domain: \( x < 2 \), Asymptote \( x = 2 \)

PTS: 4  REF: 012034aii  NAT: F.IF.C.7  TOP: Graphing Logarithmic Functions

314 ANS: 3

\[
x^2 + 2x + 1 = -5 + 1
\]

\[
(x + 1)^2 = -4
\]

\[
x + 1 = \pm 2i
\]

\[
x = -1 \pm 2i
\]

PTS: 2  REF: 081703aii  NAT: A.REI.B.4  TOP: Solving Quadratics

KEY: complex solutions | completing the square

315 ANS:

\[
0 = \sqrt{t} - 2t + 6 - 2 \left( \frac{9}{4} \right) - 6 < 0, \text{ so } \frac{9}{4} \text{ is extraneous.}
\]

\[
2t - 6 = \sqrt{t}
\]

\[
4t^2 - 24t + 36 = t
\]

\[
4t^2 - 25t + 36 = 0
\]

\[
(4t - 9)(t - 4) = 0
\]

\[
t = \frac{9}{4}, 4
\]

\[
(\sqrt{3} - 2(1) + 6) - (\sqrt{3} - 2(3) + 6) = 5 - \sqrt{3} \approx 3.268 \ 327 \text{ mph}
\]

PTS: 6  REF: 011737aii  NAT: A.REI.A.2  TOP: Solving Radicals

KEY: context
1.0525^{\frac{1}{12}} \approx 1.00427

\[ x^4 - 4x^3 - 9x^2 + 36x = 0 \]
\[ x^3(x - 4) - 9x(x - 4) = 0 \]
\[ (x^3 - 9x)(x - 4) = 0 \]
\[ x(x^2 - 9)(x - 4) = 0 \]
\[ x(x + 3)(x - 3)(x - 4) = 0 \]
x = 0, \pm 3, 4

\(\frac{\ln\left(\frac{1}{2}\right)}{1590}\) is negative, so \(M(t)\) represents decay.

\[ x^2 - x - ix - x + ix + (1 - i^2) = 0 \]
\[ x^2 - 2x + 2 = 0 \]
\[ \sqrt{x-4} = -x + 6 \quad \sqrt{x-4} = -8 + 6 = -2 \text{ is extraneous.} \]
\[ x - 4 = x^2 - 12x + 36 \]
\[ 0 = x^2 - 13x + 40 \]
\[ 0 = (x - 8)(x - 5) \]
\[ x = 5, 8 \]

**PTS: 2**  **REF: 061730aii**  **NAT: A.REI.A.2**  **TOP: Solving Radicals**
**KEY: extraneous solutions**

323 ANS: 4

\[ 4(x^2 - 6x + 9) + 4(y^2 + 18y + 81) = 76 + 36 + 324 \]
\[ 4(x - 3)^2 + 4(y + 9)^2 = 436 \]

**PTS: 2**  **REF: 061619aii**  **NAT: G.GPE.A.1**  **TOP: Equations of Circles**
**KEY: completing the square**

324 ANS:

\[ P(P / K) = \frac{P(P \times K)}{P(K)} = \frac{1.9}{2.3} \approx 82.6\% \quad \text{A key club member has an 82.6\% probability of being enrolled in AP Physics.} \]

**PTS: 4**  **REF: 011735aii**  **NAT: S.CP.B.6**  **TOP: Conditional Probability**

325 ANS: 1

(1) \( \frac{9 - 0}{2 - 1} = 9 \)  (2) \( \frac{17 - 0}{3.5 - 1} = 6.8 \)  (3) \( \frac{0 - 0}{5 - 1} = 0 \)  (4) \( \frac{17 - -5}{3.5 - 1} \approx 6.3 \)

**PTS: 4**  **REF: 011724aii**  **NAT: F.IF.B.6**  **TOP: Rate of Change**

326 ANS:

\( r(2) = -6 \). Since there is a remainder when the cubic is divided by \( x - 2 \), this binomial is not a factor.

\[
\begin{array}{cccc}
2 & 1 & -4 & 4 & 6 \\
 & 2 & -4 & 0 \\
1 & -2 & 0 & -6 \\
\end{array}
\]

**PTS: 2**  **REF: 061725aii**  **NAT: A.APR.B.2**  **TOP: Remainder Theorem**

327 ANS: 1

The graph of \( y = \sin x \) is unchanged when rotated 180\(^\circ\) about the origin.

**PTS: 2**  **REF: 081614aii**  **NAT: F.BF.B.3**  **TOP: Even and Odd Functions**

328 ANS: 4

**PTS: 2**  **REF: 061601aii**  **NAT: N.RN.A.2**  **TOP: Radicals and Rational Exponents**
**KEY: variables**
329 ANS:

Applying the commutative property, \( \left( \frac{1}{3^5} \right)^2 \) can be rewritten as \( \left( 3^2 \right)^\frac{1}{5} \) or \( 9^{\frac{1}{5}} \). A fractional exponent can be rewritten as a radical with the denominator as the index, or \( 9^{\frac{1}{5}} = \sqrt[5]{9} \).

PTS: 2 REF: 081626aii NAT: N.RN.A.1 TOP: Radicals and Rational Exponents

330 ANS: 2

The 2010 population is 110 million.

PTS: 2 REF: 061718aii NAT: F.LE.B.5 TOP: Modeling Exponential Functions

331 ANS:

\[
\begin{align*}
\begin{array}{c}
x + y + z = 1 \\
x + 2y + 3z = 1 \\
x + 3y - 5z = 11 \\
-2x - z = 3 \\
y - (-1) = 3 \\
x + 2 - 1 = 1 \\
-3z = 3 \\
y = 2 \\
x = 0 \\
y + 2z = 0 \\
4y - 4z = 12 \\
z = -1 \\
y = -2z \\
y - z = 3
\end{array}
\end{align*}
\]

PTS: 4 REF: 061733aii NAT: A.REI.C.6 TOP: Solving Linear Systems

KEY: three variables

332 ANS: 3

PTS: 2 REF: 061623aii NAT: F.BF.A.2 TOP: Sequences

333 ANS:

Let \( x \) equal the first integer and \( x + 1 \) equal the next. \((x + 1)^2 - x^2 = x^2 + 2x + 1 - x^2 = 2x + 1\). 2x + 1 is an odd integer.

PTS: 2 REF: fall1511aii NAT: A.APR.C.4 TOP: Polynomial Identities

334 ANS:

\[
\begin{align*}
-2x + 1 &= -2x^2 + 3x + 1 \\
2x^2 - 5x &= 0 \\
x(2x - 5) &= 0 \\
x &= 0, \frac{5}{2}
\end{align*}
\]

PTS: 2 REF: fall1507aii NAT: A.REI.C.7 TOP: Quadratic-Linear Systems
335 ANS:
\[ P(A \cup B) = P(A) + P(B) - P(A \cap B) \]
\[ 0.8 = 0.6 + 0.5 - P(A \cap B) \]
\[ 0.3 = 0.6 \cdot 0.5 \]
\[ P(A \cap B) = 0.3 \]

336 ANS: 3
\[ \sqrt{56-x} = x \]
\[-8 \text{ is extraneous.} \]
\[ 56 - x = x^2 \]
\[ 0 = x^2 + x - 56 \]
\[ 0 = (x + 8)(x - 7) \]
\[ x = 7 \]

337 ANS: 1
\[ \frac{A}{P} = e^{rt} \]
\[ 0.42 = e^{rt} \]
\[ \ln 0.42 = \ln e^{rt} \]
\[ -0.87 \approx rt \]

338 ANS: 1

339 ANS:
The vertex of the parabola is (4, -3). The x-coordinate of the focus and the vertex is the same. Since the distance from the vertex to the directrix is 3, the distance from the vertex to the focus is 3, so the y-coordinate of the focus is 0. The coordinates of the focus are (4, 0).
\[ x = \frac{8 \pm \sqrt{(-8)^2 - 4(6)(29)}}{2(6)} = \frac{8 \pm \sqrt{-632}}{12} = \frac{8 \pm i\sqrt{158}}{12} = \frac{2}{3} \pm \frac{1}{6} i \sqrt{158} \]

PTS: 2  REF: 011711aii  NAT: A.REI.B.4  TOP: Solving Quadratics
KEY: complex solutions | quadratic formula

\[ 100 = 325 + (68 - 325)e^{-2k} \quad T = 325 - 257e^{-0.066t} \]
\[ -225 = -257e^{-2k} \quad T = 325 - 257e^{-0.066(7)} \approx 163 \]
\[ k = \frac{\ln\left(-\frac{225}{-257}\right)}{-2} \]
\[ k \approx 0.066 \]

PTS: 4  REF: fall1513aii  NAT: F.LE.A.4  TOP: Exponential Growth

\[ (m - 2)^2(m + 3) = (m^2 - 4m + 4)(m + 3) = m^3 + 3m^2 - 4m^2 - 12m + 4m + 12 = m^3 - m^2 - 8m + 12 \]

PTS: 2  REF: 081609aii  NAT: F.BF.B.6  TOP: Sigma Notation
KEY: represent

The car lost approximately 19% of its value each year.

PTS: 2  REF: 081613aii  NAT: F.LE.B.5  TOP: Modeling Exponential Functions

\[ \frac{m(c)}{g(c)} = \frac{c + 1}{1 - c^2} = \frac{c + 1}{(1 + c)(1 - c)} = \frac{1}{1 - c} \]

PTS: 2  REF: 061608aii  NAT: F.BF.A.1  TOP: Operations with Functions
348 ANS:
\[ \sin^2 \theta + (-0.7)^2 = 1 \]
Since \( \theta \) is in Quadrant II, \( \sin \theta = \sqrt{0.51} \) and \( \tan \theta = \frac{\sin \theta}{\cos \theta} = \frac{\sqrt{0.51}}{-0.7} \approx -1.02 \)
\[ \sin^2 \theta = 0.51 \]
\[ \sin \theta = \pm \sqrt{0.51} \]

PTS: 2   REF: 081628aii   NAT: F.TF.C.8   TOP: Determining Trigonometric Functions

349 ANS:
\[ xi(-6i)^2 = xi(36i^2) = 36xi^3 = -36ix \]

PTS: 2   REF: 081627aii   NAT: N.CN.A.2   TOP: Operations with Complex Numbers

350 ANS:
\[ 0 = \log_{10}(x - 4) \]
The x-intercept of \( h \) is (2, 0). \( f \) has the larger value.
\[ 10^0 = x - 4 \]
\[ 1 = x - 4 \]
\[ x = 5 \]

PTS: 2   REF: 081630aii   NAT: F.IF.C.9   TOP: Comparing Functions

351 ANS:
\[ \frac{f(4) - f(-2)}{4 - -2} = \frac{80 - 1.25}{6} = 13.125 \]
\( g(x) \) has a greater rate of change
\[ \frac{g(4) - g(-2)}{4 - -2} = \frac{179 - 49}{6} = 38 \]

PTS: 4   REF: 061636aii   NAT: F.IF.C.9   TOP: Comparing Functions

352 ANS:
No, because \( P(M / R) \neq P(M) \)
\[ \frac{70}{180} \neq \frac{230}{490} \]
\[ 0.38 \neq 0.47 \]

PTS: 2   REF: 011731aii   NAT: S.CP.A.4   TOP: Conditional Probability

353 ANS:
\[ \frac{306.25 - 156.25}{70 - 50} = \frac{150}{20} = 7.5 \]
Between 50-70 mph, each additional mph in speed requires 7.5 more feet to stop.

PTS: 2   REF: 081631aii   NAT: F.IF.B.6   TOP: Rate of Change
\[ \frac{2x}{x-2} \left( \frac{x}{x} \right) - \frac{11}{x} \left( \frac{x-2}{x} \right) = \frac{8}{x^2 - 2x} \]

\[ 2x^2 - 11x + 22 = 8 \]
\[ 2x^2 - 11x + 14 = 0 \]
\[ (2x - 7)(x - 2) = 0 \]
\[ x = \frac{7}{2}, 2 \]

\[ y = -x + 5 \quad y = -7 + 5 = -2 \]
\[ (x - 3)^2 + (-x + 5 + 2)^2 = 16 \]
\[ x^2 - 6x + 9 + x^2 - 14x + 49 = 16 \]
\[ 2x^2 - 20x + 42 = 0 \]
\[ x^2 - 10x + 21 = 0 \]
\[ (x - 7)(x - 3) = 0 \]
\[ x = 7, 3 \]

\[ A = Pe^{rt} \]
\[ 135000 = 100000e^{5r} \]
\[ 1.35 = e^{5r} \]
\[ \ln 1.35 = \ln e^{5r} \]
\[ \ln 1.35 = 5r \]
\[ .06 \approx r \text{ or } 6\% \]
The vertex is \((1,0)\) and \(p = 2\). \(y = \frac{1}{4(2)}(x - 1)^2 + 0\)

\[A(t) = 100(0.5)^{\frac{t}{63}},\] where \(t\) is time in years, and \(A(t)\) is the amount of titanium-44 left after \(t\) years. The estimated mass at \(t = 40\) is \(100 - 40(-1.041868) \approx 58.3\). The actual mass is \(A(40) = 100(0.5)^{\frac{40}{63}} \approx 64.3976\). The estimated mass is less than the actual mass.

\[a_n = x^{n-1}(x + 1) \quad x^{n-1} = 0 \quad x + 1 = 0\]
\[x = 0 \quad x = -1\]

\[\left( p^{2}n^{\frac{1}{2}} \right)^{8} \sqrt{p^{5}n^{4}} = \left( p^{16}n^{4} \right)p^{2}n^{2} \sqrt{p} = p^{18}n^{6} \sqrt{p}\]
364 ANS:
Rewrite $\frac{4}{3}$ as $\frac{1}{3} \cdot 4$, using the power of a power rule.

PTS: 2 REF: 081725aii NAT: N.RN.A.1 TOP: Radicals and Rational Exponents

365 ANS:
At 1.95 years, the value of the car equals the loan balance. Zach can cancel the policy after 6 years.

PTS: 4 REF: 081737aii NAT: A.REI.D.11 TOP: Other Systems

366 ANS: 4
496 ± 2(115)

PTS: 2 REF: 011718aii NAT: S.ID.A.4 TOP: Normal Distributions

367 ANS:
At 1.95 years, the value of the car equals the loan balance. Zach can cancel the policy after 6 years.

PTS: 6 REF: 081637aii NAT: A.CED.A.1 TOP: Exponential Growth

368 ANS: 2
Combining (1) and (3): $-6c = -18$ Combining (1) and (2): $5a + 3c = -1$ Using (3): $-(-2) - 5b - 5(3) = 2$

\[ c = 3 \quad 5a + 3(3) = -1 \quad 2 - 5b - 15 = 2 \]

\[ 5a = -10 \quad b = -3 \]

\[ a = -2 \]
\[
\frac{1}{x} - \frac{1}{3} = \frac{1}{3x}
\]
\[
\frac{3 - x}{3x} = \frac{1}{3x}
\]
\[
3 - x = -1
\]
\[
x = 4
\]

PTS: 2  REF: 061625aii  NAT: A.REI.A.2  TOP: Solving Rationals
KEY: rational solutions

\[
6x^3 (−4xi + 5) = −24x^2 i^4 + 30x^3 i = −24x^2 (1) + 30x(−1) = −24x^2 − 30xi
\]

PTS: 2  REF: 061704aii  NAT: N.CN.A.2  TOP: Operations with Complex Numbers

ANS: 1
The zeros of the polynomial are at \(-b\), and \(c\). The sketch of a polynomial of degree 3 with a negative leading coefficient should have end behavior showing as \(x\) goes to negative infinity, \(f(x)\) goes to positive infinity. The multiplicities of the roots are correctly represented in the graph.

PTS: 2  REF: spr1501aii  NAT: F.IF.C.7  TOP: Graphing Polynomial Functions
KEY: bimodalgraph

ANS: Some of the students who did not drink energy drinks read faster than those who did drink energy drinks. 17.7 - 19.1 = -1.4 Differences of -1.4 and less occur \(\frac{25}{232}\) or about 10% of the time, so the difference is not unusual.

PTS: 4  REF: 081636aii  NAT: S.IC.B.5  TOP: Analysis of Data

ANS: A student is more likely to jog if both siblings jog. 1 jogs: \(\frac{416}{2239}\) \(\approx 0.19\). both jog: \(\frac{400}{1780}\) \(\approx 0.22\)

PTS: 2  REF: 061732aii  NAT: S.CP.A.4  TOP: Conditional Probability

\[
x + 2\sigma\text{ represents approximately } 48\% \text{ of the data.}
\]

PTS: 2  REF: 061609aii  NAT: S.ID.A.4  TOP: Normal Distributions
KEY: percent
375 ANS: 4

\[
\text{period} = \frac{2\pi}{B} \\
\frac{1}{60} = \frac{2\pi}{B} \\
B = 120\pi
\]

PTS: 2  REF: 061624aii  NAT: F.TF.B.5  TOP: Modeling Trigonometric Functions

376 ANS:

\[
\text{4\%} \quad 8.75 = 1.25(1 + r)^{49} \text{ or } 8.75 = 1.25e^{49r} \\
7 = (1 + r)^{49} \quad \ln 7 = \ln e^{49r} \\
r + 1 = \sqrt[49]{7} \quad \ln 7 = 49r \\
r \approx 0.04 \quad r = \frac{\ln 7}{49} \quad r \approx 0.04
\]

PTS: 2  REF: 081730aii  NAT: F.LE.A.4  TOP: Exponential Growth

377 ANS: 2  PTS: 2  REF: 061620aii  NAT: F.IF.B.4  TOP: Graphing Polynomial Functions

378 ANS:

PTS: 2  REF: 061729aii  NAT: F.IF.C.7  TOP: Graphing Exponential Functions
379 ANS:

\[
\begin{array}{c}
x - 5 \quad 2x^2 + 6x + 23 \\
2x^3 - 4x^2 - 7x - 10 \\
2x^3 - 10x^2 \\
6x^2 - 7x \\
6x^2 - 30x \\
23x - 10 \\
23x - 115 \\
105
\end{array}
\]

Since there is a remainder, \( x - 5 \) is not a factor.

PTS: 2 REF: 061627aii NAT: A.APR.B.2 TOP: Remainder Theorem

380 ANS: 1

PTS: 2 REF: 061618aii NAT: A.APR.B.2 TOP: Remainder Theorem

381 ANS:

\[
\begin{align*}
7 &= 20(0.5)^\frac{t}{8.02} \\
\log 0.35 &= \log 0.5 \\
\log 0.35 &= \frac{t \log 0.5}{8.02} \\
8.02 \log 0.35 &= t \\
\log 0.5 &= t
\end{align*}
\]

\[t \approx 12\]

PTS: 4 REF: 081634aii NAT: F.LE.A.4 TOP: Exponential Decay
\begin{align*}
x &= \frac{3}{4}y + 2 \\
-4x &= 3y - 8 \\
-4x + 8 &= 3y \\
\frac{4}{3}x + \frac{8}{3} &= y
\end{align*}

\text{PTS: 2} \quad \text{REF: 061616aii} \quad \text{NAT: F.BF.B.4} \quad \text{TOP: Inverse of Functions}

\text{KEY: linear}

\begin{align*}
f(4) &= 2(4)^3 - 5(4)^2 - 11(4) - 4 = 128 - 80 - 44 - 4 = 0 \quad \text{Any method that demonstrates 4 is a zero of } f(x) \text{ confirms that } x - 4 \text{ is a factor, as suggested by the Remainder Theorem.}
\end{align*}

\text{PTS: 2} \quad \text{REF: spr1507aii} \quad \text{NAT: A.APR.B.2} \quad \text{TOP: Remainder Theorem}

\begin{align*}
\text{The maximum volume of } \ p(x) &= -(x + 2)(x - 10)(x - 14) \text{ is about 56, at } x = 12.1
\end{align*}

\text{PTS: 2} \quad \text{REF: 081712aii} \quad \text{NAT: F.IF.B.4} \quad \text{TOP: Graphing Polynomial Functions}

\begin{align*}
0 &= 6(-5)^3 + b(-5)^2 - 52(-5) + 15 \quad z(x) = 6x^3 + 19x^2 - 52x + 15 \\
0 &= -750 + 25b + 260 + 15 \\
475 &= 25b \\
19 &= b
\end{align*}

\begin{array}{cccc}
-5 & 6 & 19 & -52 & 15 \\
-30 & 55 & 15
\end{array}

\begin{align*}
6x^2 - 11x + 3 &= 0 \\
(2x - 3)(3x - 1) &= 0 \\
x &= \frac{3}{2}, \frac{1}{3}, -5
\end{align*}

\text{PTS: 4} \quad \text{REF: fall1515aii} \quad \text{NAT: A.APR.B.2} \quad \text{TOP: Remainder Theorem}
Based on these data, the two events do not appear to be independent. \( P(F) = \frac{106}{200} = 0.53 \), while \( P(F|T) = \frac{54}{90} = 0.6 \), \( P(F|R) = \frac{25}{65} = 0.39 \), and \( P(F|C) = \frac{27}{45} = 0.6 \). The probability of being female are not the same as the conditional probabilities. This suggests that the events are not independent.

\[
720 = \frac{120000 \left( \frac{0.048}{12} \right) \left( 1 + \frac{0.048}{12} \right)^n}{1 + \frac{0.048}{12}} - 1
\]

\[
\frac{275.2}{12} \approx 23 \text{ years}
\]

\[
720(1.004)^n - 720 = 480(1.004)^n
\]

\[
240(1.004)^n = 720
\]

\[
1.004^n = 3
\]

\[
n \log 1.004 = \log 3
\]

\[
n \approx 275.2 \text{ months}
\]
391 ANS:

\[
3\sqrt[3]{x} \cdot \sqrt[3]{x} = x^{\frac{1}{3}} \cdot x^{\frac{1}{3}} = x^{\frac{1}{3} + \frac{1}{3}} = x^{\frac{2}{3}}
\]


392 ANS: 2

\[B(t) = 750 \left(1 + \frac{0.16}{12}\right)^{12t}\]

\[\approx 750(1.012)^{12t}\]

\[B(t) = 750 \left(1 + \frac{0.16}{12}\right)^{12t}\]

is wrong, because the growth is an annual rate that is not compounded monthly.

PTS: 2 REF: spr1504aii NAT: A.SSE.B.3 TOP: Modeling Exponential Functions

393 ANS: 2

\[
\begin{array}{c|cccc}
-4 & 1 & -11 & 16 & 84 \\
1 & -4 & 60 & -304 \\
\hline
1 & -15 & 76 & \end{array}
\]

Since there is a remainder when the cubic is divided by \(x + 4\), this binomial is not a factor.

PTS: 2 REF: 081720aii NAT: A.APR.B.2 TOP: Remainder Theorem

394 ANS: 4

\[
\left(\frac{-54x^9}{y^4}\right)^{\frac{2}{3}} = \left(2 \cdot -27\right)^{\frac{2}{3}} x^{\frac{18}{3}} y^{\frac{-8}{3}} = \frac{2^2 \cdot 9x^6}{y^2 \cdot y^{\frac{2}{3}}} = \frac{9x^6 \sqrt[3]{4}}{y^2 \sqrt[3]{y^2}}
\]

PTS: 2 REF: 081723aii NAT: N.RN.A.2 TOP: Radicals and Rational Exponents KEY: variables

395 ANS:

Since there are six flavors, each flavor can be assigned a number, 1-6. Use the simulation to see the number of times the same number is rolled 4 times in a row.

PTS: 2 REF: 081728aii NAT: S.IC.A.2 TOP: Analysis of Data

396 ANS: 4

<table>
<thead>
<tr>
<th>Bar Harbor</th>
<th>Phoenix</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum</td>
<td>31.386</td>
</tr>
<tr>
<td>Midline</td>
<td>55.3</td>
</tr>
<tr>
<td>Maximum</td>
<td>79.214</td>
</tr>
<tr>
<td>Range</td>
<td>47.828</td>
</tr>
</tbody>
</table>

PTS: 2 REF: 061715aii NAT: F.IF.B.4 TOP: Graphing Trigonometric Functions KEY: maximum/minimum
397 ANS:
\[
\begin{pmatrix}
\frac{5}{3} \\
\frac{6}{5}
\end{pmatrix}
= \begin{pmatrix}
\frac{5}{6} \\
\frac{6}{5}
\end{pmatrix}
\]
\[x^2 = y\]

PTS: 2 REF: 011730aii NAT: N.RN.A.2 TOP: Radicals and Rational Exponents KEY: variables

398 ANS:
\[
100 = 140 \left( \frac{1}{2} \right)^{\frac{5}{h}} \quad \log_{10} \frac{100}{140} = \log_{10} \left( \frac{1}{2} \right)^{\frac{5}{h}} \\
40 = 140 \left( \frac{1}{2} \right)^{\frac{t}{10.3002}} \quad \log_{10} \frac{40}{140} = \log_{10} \left( \frac{1}{2} \right)^{\frac{t}{10.3002}}
\]
\[
\log_{10} \frac{7}{2} = \frac{5}{h} \log_{10} \frac{1}{2} \quad \log_{10} \frac{7}{2} = \log_{10} \left( \frac{1}{2} \right)^{\frac{5}{h}}
\]
\[
h = \frac{5 \log_{10} \frac{1}{2}}{\log_{10} \frac{7}{2}} \approx 10.3002
\]
\[
\log_{10} \frac{2}{7} = \frac{t \log_{10} \frac{1}{2}}{10.3002}
\]
\[
t = \frac{10.3002 \log_{10} \frac{2}{7}}{\log_{10} \frac{1}{2}} \approx 18.6
\]

PTS: 6 REF: 061737aii NAT: F.LE.A.4 TOP: Exponential Decay

399 ANS: 4
\[
y = g(x) = (x - 2)^2 \quad (x - 2)^2 = 3x - 2 \quad y = 3(6) - 2 = 16
\]
\[
x^2 - 4x + 4 = 3x - 2 \quad y = 3(1) - 2 = 1
\]
\[
x^2 - 7x + 6 = 0
\]
\[
(x - 6)(x - 1) = 0
\]
\[
x = 6, 1
\]

PTS: 2 REF: 011705aii NAT: A.REL.C.7 TOP: Quadratic-Linear Systems
\[ \sqrt{x + 14} = \sqrt{2x + 5} + 1 \quad \sqrt{22 + 14} - \sqrt{2(22) + 5} = 1 \]
\[ x + 14 = 2x + 5 + 2\sqrt{2x + 5} + 1 \quad x + 8 = 2\sqrt{2x + 5} \]
\[ x^2 - 16x + 64 = 8x + 20 \]
\[ x^2 - 24x + 44 = 0 \]
\[ (x - 22)(x - 2) = 0 \]
\[ x = 2, 22 \]

• PTS: 2  REF: 081704aii  NAT: A.REI.A.2  TOP: Solving Radicals
  KEY: advanced

\[ 8(2^{x+3}) = 48 \]
\[ 2^{x+3} = 6 \]
\[ (x + 3) \ln 2 = \ln 6 \]
\[ x + 3 = \frac{\ln 6}{\ln 2} \]
\[ x = \frac{\ln 6}{\ln 2} - 3 \]

• PTS: 2  REF: 061702aii  NAT: F.LE.A.4  TOP: Exponential Equations
  KEY: without common base

\[ \frac{3x + 13}{x - 2} = \frac{3x^2 + 7x - 20}{3x^2 - 6x} \]
\[ 3x + 13 + \frac{6}{x - 2} \]
\[ 13x - 20 \]
\[ 13x - 26 \]
\[ 6 \]

• PTS: 2  REF: 011732aii  NAT: A.APR.D.6  TOP: Rational Expressions
  KEY: division

\[ \text{TOP: Graphing Trigonometric Functions} \quad \text{KEY: increasing/decreasing} \]
1) Let $y = x + 2$, then $y^2 + 2y - 8$

$$(y + 4)(y - 2)$$

$$(x + 2 + 4)(x + 2 - 2)$$

$$(x + 6)x$$

\[ j(-x) = (-x)^4 - 3(-x)^2 - 4 = x^4 - 3x^2 - 4 \]

Since $j(x) = j(-x)$, the function is even.

\[ \cos \theta = \pm \sqrt{1 - \left(\frac{-\sqrt{2}}{3}\right)^2} = \pm \sqrt{\frac{25}{25} - \frac{2}{25}} = \pm \frac{\sqrt{23}}{5} \]

Light wave C. The periods for A, B, and C are 280, 220 and 320.
412 ANS:
\[ x = (y - 3)^3 + 1 \]
\[ x - 1 = (y - 3)^3 \]
\[ 3\sqrt{x - 1} = y - 3 \]
\[ 3\sqrt{x - 1} + 3 = y \]
\[ f^{-1}(x) = 3\sqrt{x - 1} + 3 \]

413 ANS: 4

414 ANS: 2
\[ (2 - yi)(2 - yi) = 4 - 4yi + y^2 i^2 = -y^2 - 4yi + 4 \]

415 ANS:
\[ y = 4.168(3.981)^x \]
\[ 100 = 4.168(3.981)^x \]
\[ \frac{\log 100}{\log 4.168} = x \log(3.981) \]
\[ \frac{\log 100}{\log(3.981)} = x \]
\[ x \approx 2.25 \]

416 ANS: 1
II. Ninth graders drive to school less often; III. Students know little about adults; IV. Calculus students love math!

417 ANS: 4
\[ d = 32(0.8)^{b-1} \]
\[ S_n = \frac{32 - 32(0.8)^{12}}{1 - 0.8} \approx 149 \]

PTS: 2
\[ -2 \left( \frac{1}{2} x^2 = -6x + 20 \right) \]
\[ x^2 - 12x = -40 \]
\[ x^2 - 12x + 36 = -40 + 36 \]
\[ (x - 6)^2 = -4 \]
\[ x - 6 = \pm 2i \]
\[ x = 6 \pm 2i \]

This scenario can be modeled with a Venn Diagram. Since \( P(S \cup I) = 0.2 \), \( P(S \cup I) = 0.8 \). Then, \( P(S \cap I) = P(S) + P(I) - P(S \cup I) \) If \( S \) and \( I \) are independent, then the
\[ = 0.5 + 0.7 - 0.8 \]
\[ = 0.4 \]
Product Rule must be satisfied. However, \( (0.5)(0.7) \neq 0.4 \). Therefore, salary and insurance have not been treated independently.

Part a sketch is shifted \( \frac{\pi}{3} \) units right.

Part a sketch is shifted \( \frac{\pi}{3} \) units right.
421 ANS: 1  
\[ P(28) = 5(2)^{\frac{98}{28}} \approx 56 \]

PTS: 2         REF: 011702aii        NAT: F.LE.A.2        TOP: Modeling Exponential Functions

422 ANS:
\[ P(S \cap M) = P(S) + P(M) - P(S \cup M) = \frac{649}{1376} + \frac{433}{1376} - \frac{974}{1376} = \frac{108}{1376} \]

PTS: 2         REF: 061629aii        NAT: S.CP.B.7        TOP: Theoretical Probability

423 ANS:
\[ y = -x + 1 \quad y = -2 + 1 = -1 \quad (2, -1) \]
\[ (x - 2)^2 + (-x + 1 - 3)^2 = 16 \quad y = 2 + 1 = 3 \quad (-2, 3) \]
\[ x^2 - 4x + 4 + x^2 + 4x + 4 = 16 \]
\[ 2x^2 = 8 \]
\[ x = -2, 2 \]

PTS: 4         REF: 012035aii        NAT: A.REI.C.7        TOP: Quadratic-Linear Systems

424 ANS: 3  
\[ \log_{0.8} \left( \frac{V}{17000} \right) = t \]
\[ \frac{17,000(0.8)^3 - 17,000(0.8)^1}{3 - 1} \approx -2450 \]
\[ 0.8^t = \frac{V}{17000} \]
\[ V = 17000(0.8)^t \]

PTS: 2         REF: 081709aii        NAT: F.IF.B.6        TOP: Rate of Change
425 ANS: 
\[ y = 101.523^{(0.883)^x} \] 
\[ 29 = 101.523^{(0.883)^x} \] 
\[ \frac{29}{101.523} = (0.883)^x \] 
\[ \log \frac{29}{101.523} = x \log(0.883) \] 
\[ \frac{29}{\log(0.883)} = x \] 
\[ x \approx 10.07 \]

PTS: 4 REF: 012036aii NAT: S.ID.B.6 TOP: Regression KEY: exponential

426 ANS: 
Jillian’s plan, because distance increases by one mile each week. 
\[ a_1 = 10 \] 
\[ a_n = n + 12 \] 
\[ a_n = a_{n-1} + 1 \]

PTS: 4 REF: 011734aii NAT: F.LE.A.2 TOP: Sequences KEY: recursive

427 ANS: 
The mean difference between the students’ final grades in group 1 and group 2 is –3.64. This value indicates that students who met with a tutor had a mean final grade of 3.64 points less than students who used an on-line subscription. One can infer whether this difference is due to the differences in intervention or due to which students were assigned to each group by using a simulation to rerandomize the students’ final grades many (500) times. If the observed difference –3.64 is the result of the assignment of students to groups alone, then a difference of –3 or less should be observed fairly regularly in the simulation output. However, a difference of –3 or less occurs in only about 2% of the rerandomizations. Therefore, it is quite unlikely that the assignment to groups alone accounts for the difference; rather, it is likely that the difference between the interventions themselves accounts for the difference between the two groups’ mean final grades.

PTS: 4 REF: fall1514aii NAT: S.IC.B.5 TOP: Analysis of Data

428 ANS: 
\[ \frac{3p}{p - 5} = \frac{p + 2}{p + 3} \] 
\[ 3p^2 + 9p = p^2 - 3p - 10 \] 
\[ 2p^2 + 12p + 10 = 0 \] 
\[ p^2 + 6p + 5 = 0 \] 
\[ (p + 5)(p + 1) = 0 \] 
\[ p = -5, -1 \]

429 ANS:
\[2x^3 - 10x^2 + 11x - 7 = 2x^3 + hx^2 + 3x - 8x^2 - 4hx - 12 + k\]
\[-2x^2 + 8x + 5 = hx^2 - 4hx + k\]
\[h = -2\]
\[k = 5\]

PTS: 4 REF: 011733aii NAT: A.APR.C.4 TOP: Polynomial Identities

430 ANS: 2

The events are independent because \(P(A \text{ and } B) = P(A) \cdot P(B)\).

\[0.125 = 0.5 \cdot 0.25\]

If \(P(A \text{ or } B) = P(A) + P(B) - P(A \text{ and } B) = 0.25 + 0.5 - 0.125 = 0.625\), then the events are not mutually exclusive because \(P(A \text{ or } B) = P(A) + P(B)\)

\[0.625 \neq 0.5 + 0.25\]

PTS: 2 REF: 061714aii NAT: S.CP.B.7 TOP: Theoretical Probability

431 ANS: 3 PTS: 2 REF: 011708aii NAT: F.BF.B.4

TOP: Inverse of Functions KEY: other

432 ANS: 1

PTS: 2 REF: 081711aii NAT: S.ID.A.4 TOP: Normal Distributions KEY: percent

433 ANS: 4 PTS: 2 REF: 081624aii NAT: F.BF.A.2

TOP: Sequences

434 ANS:

PTS: 2 REF: fall1510aii NAT: A.REI.D.11 TOP: Other Systems

435 ANS: 2 PTS: 2 REF: 081717aii NAT: S.IC.B.3

TOP: Analysis of Data KEY: type
0.602 ± 2 · 0.066 = 0.47 – 0.73. Since 0.50 falls within the 95% interval, this supports the concern there may be an even split.

A parabola with a focus of (0,4) and a directrix of \( y = 2 \) is sketched as follows: By inspection, it is determined that the vertex of the parabola is (0,3). It is also evident that the distance, \( p \), between the vertex and the focus is 1. It is possible to use the formula \((x - h)^2 = 4p(y - k)\) to derive the equation of the parabola as follows: \((x - 0)^2 = 4(1)(y - 3)\)

\[
x^2 = 4y - 12
\]

\[
x^2 + 12 = 4y
\]

\[
\frac{x^2}{4} + 3 = y
\]

or A point \((x,y)\) on the parabola must be the same distance from the focus as it is from the directrix. For any such point \((x,y)\), the distance to the focus is \(\sqrt{(x-0)^2 + (y-4)^2}\) and the distance to the directrix is \(y - 2\). Setting this equal leads to: \(x^2 + y^2 - 8y + 16 = y^2 - 4y + 4\)

\[
x^2 + 16 = 4y + 4
\]

\[
\frac{x^2}{4} + 3 = y
\]
\[
\begin{align*}
\text{ANS: } & \quad \frac{157}{25 + 47 + 157} \\
\text{PTS: } & \quad 2 \quad \text{REF: 081607aii} \quad \text{NAT: S.CP.A.4} \quad \text{TOP: Conditional Probability}
\end{align*}
\]

\[
\begin{align*}
\text{ANS: } & \quad 4 \\
\text{PTS: } & \quad 2 \quad \text{REF: 081635aii} \quad \text{NAT: A.REI.A.2} \quad \text{TOP: Solving Radicals} \\
\text{KEY: extraneous solutions}
\end{align*}
\]

\[
\begin{align*}
\text{ANS: } & \quad \frac{B(60) - B(10)}{60 - 10} \approx 28\% \quad \frac{B(69) - B(19)}{69 - 19} \approx 33\% \quad \frac{B(72) - B(36)}{72 - 36} \approx 38\% \quad \frac{B(73) - B(60)}{73 - 60} \approx 46\%
\end{align*}
\]

\[
\begin{align*}
\text{ANS: } & \quad \left(\sqrt{2x - 7}\right)^2 = (5 - x)^2 \quad \sqrt{2(4) - 7} + 4 = 5 \quad \sqrt{2(8) - 7} + 8 = 5 \\
& \quad 2x - 7 = 25 - 10x + x^2 \quad \sqrt{1} = 1 \quad \sqrt{9} \neq -3 \\
& \quad 0 = x^2 - 12x + 32 \quad 0 = (x - 8)(x - 4) \\
& \quad x = 4, 8
\end{align*}
\]

\[
\begin{align*}
\text{ANS: } & \quad m(3) = 3^3 - 3^2 - 5(3) - 3 = 27 - 9 - 15 - 3 = 0 \quad \text{Since } m(3) = 0, \text{ there is no remainder when } m(x) \text{ is divided by } x - 3, \\
& \quad \text{and so } x - 3 \text{ is a factor.}
\end{align*}
\]

\[
\begin{align*}
\text{ANS: } & \quad \text{Graph of a polynomial function}
\end{align*}
\]

\[
\begin{align*}
\text{ANS: } & \quad \text{Graph of a polynomial function}
\end{align*}
\]

\[
\begin{align*}
\text{PTS: } & \quad 2 \quad \text{REF: 011729aii} \quad \text{NAT: F.IF.C.7} \quad \text{TOP: Graphing Polynomial Functions}
\end{align*}
\]

\[
\begin{align*}
\text{PTS: } & \quad 4 \quad \text{REF: fall1516aii} \quad \text{NAT: S.ID.A.4} \quad \text{TOP: Normal Distributions} \\
\text{KEY: probability}
\end{align*}
\]
Translation 3 units right and 4 units up

\[ y = -\frac{1}{4(2)} (x - 2)^2 - 1 \]

The vertex is \((2, -1)\) and \(p = 2\).

\[ x = \frac{-3 \pm \sqrt{3^2 - 4(2)(2)}}{2(2)} = \frac{-3 \pm \sqrt{-7}}{4} = \frac{-3}{4} \pm \frac{i\sqrt{7}}{4} \]

The pattern suggests an exponential pattern, not linear or sinusoidal. A 4% growth rate is accurate, while a 43% growth rate is not.

vertex \((3,6)\), focus \((3,1)\), \(p = 5\), directrix \(y = 6 + 5 = 11\)
ANS:
\[ 6x - 3y + 2z = -10 \quad x + 3y + 5z = 45 \quad 4x + 10z = 62 \quad 4x + 4(7) = 20 \quad 6(-2) - 3y + 2(7) = -10 \]
\[-2x + 3y + 8z = 72 \quad 6x - 3y + 2z = -10 \quad 4x + 4z = 20 \quad 4x = -8 \quad -3y = -12 \]
\[ 4x + 10z = 62 \quad 7x + 7z = 35 \quad 6z = 42 \quad x = -2 \quad y = 4 \]
\[ 4x + 4z = 20 \quad z = 7 \]

PTS: 4  REF: spr1510aii  NAT: A.REI.C.6  TOP: Solving Linear Systems
KEY: three variables

457  ANS: 1
\[ d = 18; \quad r = \pm \frac{5}{4} \]

PTS: 2  REF: 011714aii  NAT: F.IF.A.3  TOP: Sequences
KEY: explicit

458  ANS: 1
\[ \frac{2(x - 4)}{(x + 3)(x - 4)} + \frac{3(x + 3)}{(x - 4)(x + 3)} = \frac{2x - 2}{x^2 - x - 12} \]
\[ 2x - 8 + 3x + 9 = 2x - 2 \]
\[ 3x = -3 \]
\[ x = -1 \]

PTS: 2  REF: 011717aii  NAT: A.REI.A.2  TOP: Solving Rationals
KEY: rational solutions

459  ANS: 4
\[ \frac{-3x^2 - 5x + 2}{x^3 + 2x^2} = \frac{(-3x + 1)(x + 2)}{x^2(x + 2)} = \frac{-3x + \frac{1}{x}}{x^2} = -3x^{-1} + x^{-2} \]

PTS: 2  REF: 061723aii  NAT: A.APR.D.6  TOP: Expressions with Negative Exponents
KEY: variables

460  ANS: 3
\[ -33r^2 + 360t = 700 + 5t \]
\[ -33r^2 + 355t - 700 = 0 \]
\[ t = \frac{-355 \pm \sqrt{355^2 - 4(-33)(-700)}}{2(-33)} \approx 3,8 \]


461  ANS: 3
The graph shows three real zeros, and has end behavior matching the given end behavior.

PTS: 2  REF: 061604aii  NAT: F.IF.C.7  TOP: Graphing Polynomial Functions
KEY: bimodalgraph
462 ANS: 4

\[ y = 5^{-t} = \left( \frac{1}{5} \right)^t \]

PTS: 2    REF: 061615aii    NAT: F.IF.C.7    TOP: Graphing Exponential Functions

463 ANS: 3
Self selection causes bias.

PTS: 2    REF: 061703aii    NAT: S.IC.B.3    TOP: Analysis of Data
KEY: bias

464 ANS:

\[ 20000 = PMT \left( \frac{1 - (1 + .00625)^{-60}}{0.00625} \right) \]
\[ 21000 - x = 300 \left( \frac{1 - (1 + .00625)^{-60}}{0.00625} \right) \]

\[ PMT \approx 400.76 \]
\[ x \approx 6028 \]

PTS: 4    REF: 011736aii    NAT: A.SSE.B.4    TOP: Series

465 ANS: 3

\[ 2d(d^3 + 3d^2 - 9d - 27) \]
\[ 2d(d^2(d + 3) - 9(d + 3)) \]
\[ 2d(d^2 - 9)(d + 3) \]
\[ 2d(d + 3)(d - 3)(d + 3) \]
\[ 2d(d + 3)^2(d - 3) \]

PTS: 2    REF: 081615aii    NAT: A.SSE.A.2    TOP: Factoring Polynomials
KEY: factoring by grouping

466 ANS: 3

(3) repeats 3 times over \( 2\pi \).

PTS: 2    REF: 011722aii    NAT: F.IF.C.7    TOP: Graphing Trigonometric Functions
KEY: recognize | bimodalgraph
The amplitude, 12, can be interpreted from the situation, since the water level has a minimum of $-12$ and a maximum of 12. The value of $A$ is $-12$ since at 8:30 it is low tide. The period of the function is 13 hours, and is expressed in the function through the parameter $B$. By experimentation with technology or using the relation $P = \frac{2\pi}{B}$ (where $P$ is the period), it is determined that $B = \frac{2\pi}{13}$.

$$f(t) = -12\cos\left(\frac{2\pi}{13}t\right)$$

In order to answer the question about when to fish, the student must interpret the function and determine which choice, 7:30 pm or 10:30 pm, is on an increasing interval. Since the function is increasing from $t = 13$ to $t = 19.5$ (which corresponds to 9:30 pm to 4:00 am), 10:30 is the appropriate choice.

$$d = 10\log\frac{6.3 \times 10^{-3}}{1.0 \times 10^{-12}} \approx 98$$
470 ANS:

\[
\text{antibiotic } n(0) = \frac{0 + 1}{0 + 5} + \frac{18}{0^2 + 8(0) + 15} = \frac{3}{15} + \frac{18}{15} = \frac{21}{15} \\
\text{and } a(0) = \frac{9}{0 + 3} = 3
\]

\[
\frac{t + 1}{t + 5} + \frac{18}{t^2 + 8t + 15} = \frac{9}{t + 3}
\]

\[
(t + 1)(t + 3) + \frac{18}{(t + 5)(t + 3)} = \frac{9(t + 5)}{(t + 3)(t + 5)}
\]

\[
t^2 + 4t + 3 + 18 = 9t + 45
\]

\[
t^2 - 5t - 24 = 0
\]

\[
(t - 8)(t + 3) = 0
\]

\[
t = 8
\]

PTS: 6 REF: 012037aii NAT: A.REI.A.2 TOP: Solving Rationals

KEY: rational solutions

471 ANS: 3

\[
(3k - 2i)^2 = 9k^2 - 12ki + 4i^2 = 9k^2 - 12ki - 4
\]

PTS: 2 REF: 081702aii NAT: N.CN.A.2 TOP: Operations with Complex Numbers

472 ANS: 4

\[
(x + y)^3 = x^3 + 3x^2y + 3xy^2 + y^3 \neq x^3 + 3xy + y^3
\]

PTS: 2 REF: 081620aii NAT: A.APR.C.4 TOP: Polynomial Identities

473 ANS:

sample: pails of oranges; population: truckload of oranges. It is likely that about 5% of all the oranges are unsatisfactory.

PTS: 2 REF: 011726aii NAT: S.IC.A.2 TOP: Analysis of Data

474 ANS: 4

\[
4x^2 = -98
\]

\[
x^2 = \frac{-98}{4}
\]

\[
x^2 = \frac{-49}{2}
\]

\[
x = \pm \sqrt{\frac{-49}{2}} = \pm \frac{7i\sqrt{2}}{2} = \pm \frac{7i\sqrt{2}}{2}
\]

PTS: 2 REF: 061707aii NAT: A.REI.B.4 TOP: Solving Quadratics

KEY: complex solutions | taking square roots
\[
\frac{2x^2 + x + 5}{2x - 1} \left( \frac{4x^3 + 0x^2 + 9x - 5}{4x^3 - 2x^2} \right)
\]

\[
2x^2 + 9x
\]

\[
2x^2 - x
\]

\[
10x - 5
\]

PTS: 2       REF: 081713aii       NAT: A.APR.D.6       TOP: Rational Expressions

KEY: division